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ABSTRACT

The guide contains 11 sections, each consisting of one or more units of instruction designed to provide students with entry-level skills in auto body repair. The sections deal with: introductory and related information; body and frame construction; tools; welding; basic metal repair; hardware, glass, and trim; major metal repair; refinishing; damage estimating; and miscellaneous topics. Each unit includes performance objectives stated as terminal objectives, indicating the subject matter to be covered, and as specific objectives for student performance. All units contain suggested student and teacher activities, information sheets providing the essential content of the unit, tests with answers, and a reference list. Many of the units also have transparency masters, student handout sheets, job sheets designed to teach a skill, and assignment sheets to provide paper and pencil activities. Numerous illustrations are included on the assignment and job sheets, tests, and transparency masters. Progress charts, with predetermined levels of accuracy for evaluating skill attainment, are provided after each major section and contain a listing of all the tasks for which job sheets are included in the units. (Author/MS)

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AUTO BODY

Repair and Repainting

U S DEPARTMENT OF HEALTH,
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INSTRUCTIONAL UNITS

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FOREWORD

This publication is designed to provide instruction leading toward entry level employment as an auto body repairman. Today, trade teachers are faced with the increasing problem of what to teach and how to teach it. The student of today, who will be the tradesman of tomorrow, needs to be a well educated individual who is socially adjusted and a productive individual in this modern society. The purpose of this manual is to provide a base for auto body instructors which will aid in the standardization of instruction throughout the industry. This publication should not be considered as the complete text for auto body repair, but should be supplemented by each instructor to meet his specific needs. Keep in mind that these instructional units are designed to provide entry level instruction in auto body repair.

Francis T. Tuttle
State Director, State Department
of Vocational and Technical Education

Roy Ayres
State Supervisor, Trade and
Industrial Education

PREFACE

The demand for instructional material for use in public school vocational auto body programs has been heard and this publication is in response to that cry.

Instructional material written in terms of student performance using measurable performance objectives is an innovative approach to teaching that accents and augments the teaching-learning process. Criterion referenced tests provide for a uniform measurement of student progress while progress charts with preestablished accuracy levels provide a ready reference for student and instructor.

This publication is designed to provide a basic curriculum for instruction in several specialized areas that require a thorough knowledge of auto body repair. Auto body instructors throughout the nation are faced with the challenge of providing students with the skill and related information necessary to meet the demands of a changing profession. Competition is greater than ever, therefore, the auto body repairman must be better trained and better equipped to find meaningful employment.

The purpose of this manual is to assist auto body instructors, at all levels, in improving instruction uniformly throughout the industry. This publication should be supplemented by each instructor's methods and materials. Any information in this manual that does not fit into his course of study can very easily be altered.

Edward F. Manuel

Wayman R. Penner

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USE OF THIS PUBLICATION

Instructional Units

Auto Body curriculum includes eleven sections. Each section consists of one or more units of instruction. Each instructional unit includes performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help him determine:

- A. The amount of material that can be covered in each class period.
- B. The skills which must be demonstrated.
  - 1. Supplies needed
  - 2. Equipment needed
  - 3. Amount of practice needed
  - 4. Amount of class time needed for demonstrations
- C. Supplementary materials such as pamphlets and filmstrips that must be ordered.
- D. Resource people that must be contacted.

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: Terminal Objectives stating the subject matter to be covered in a unit of instruction and Specific Objectives stating the student performance necessary to reach the terminal objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which were used in this material:

Name	Identify	Describe
Label	Select	Define
List in writing	Mark	Discuss in writing
List orally	Point out	Discuss orally
Letter	Pick out	Interpret
Record	Choose	Tell how
Repeat	Locate	Tell what
Give		Explain

Order
Arrange
Sequence
List in order
Classify
Divide
Isolate
Sort

Distinguish
Discriminate

Construct
Draw
Make
Build
Design
Formulate
Reproduce
Transcribe
Reduce
Increase
Figure
Cost

Demonstrate
Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of his students and community. When a teacher adds objectives, he should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities

Each unit of instruction has a Suggested Activities sheet outlining steps to follow in accomplishing specific objectives. The activities are listed according to whether they are the responsibility of the instructor or the student.

Instructor: Duties of the instructor will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheets, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss terminal and specific objectives and information sheets; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Students: Student activities are listed which will help the student to achieve the objectives for the unit.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives of the unit. The teacher will find that information sheets serve as an excellent guide for presenting the background knowledges necessary to develop the skills specified in the terminal objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective for such activities as learning and locating the parts of a machine.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion. (NOTE: Stand away from the overhead projector when discussing transparency material. The noise of the projector may cause the teacher to speak too loudly.)

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for a student to follow if he has missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances he might reasonably expect from a person who has had this training.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the terminal objective. Test items for objectives added by the teacher should be constructed and added to the test. Progress sheets are provided for student and teacher to record acceptable performance of skills outlined in job sheets.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

Progress Charts

Progress charts are provided after each major section and contain a listing of all of the tasks for which job sheets are included in the units. Predetermined levels of accuracy are also provided to assist the instructor and student in evaluating skill attainment. Additional blanks are provided for the inclusion of additional tasks as the instructor deems necessary.

ORIENTATION
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define Trade and Industrial Education, name ten T & I trades, list six student requirements for T & I programs, and list three facts concerning the occupational outlook for auto body repairmen. He should also name employment opportunities, name the youth club, list reasons for joining, define VICA, and complete a personal information sheet. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define Trade and Industrial Education.
2. Name ten trades for which training is offered in high school programs.
3. List six student requirements for T & I programs.
4. List three facts concerning the occupational outlook for auto body repairmen.
5. Name four employment opportunities for auto body repairmen.
6. Name the youth club that T & I students may join.
7. List four reasons for joining the T & I youth club.
8. Define VICA.
9. Complete a personal information sheet.

ORIENTATION
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and assignment sheets.
- C. Discuss terminal and specific objectives.
- D. Discuss information and assignment sheets.
- E. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete assignment sheet.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Assignment Sheet #1--Personal Information Sheet
- D. Test
- E. Answers to test

II. References:

- A. *Official Guide for Vocational Industrial Clubs of America.* Washington, D.C.: Vocational Industrial Clubs of America.
- B. *Occupational Outlook Handbook.* 1970-71 Edition. U. S. Department of Labor, Bureau of Labor Statistics, Bulletin No. 1650.

ORIENTATION
UNIT I

INFORMATION SHEET

I. Trade and Industrial Education--An organized program of instruction covering desirable knowledges, skills, and attitudes that pertain to any custom trade, service trade, or occupation which is not classified as agricultural, business, technical, professional, or homemaking

II. Trades offered in high school T & I programs

A. Air conditioning and refrigeration

B. Aircraft mechanics

C. Appliance repair

D. Auto body repair and painting

E. Auto mechanics

F. Brick masonry

G. Cabinetmaking

H. Carpentry

I. Commercial art

J. Cooperative vocational education

K. Cosmetology

L. Diesel mechanics

M. Drafting

N. Electricity

O. Electronics

P. Farm equipment repair

Q. Heavy equipment operation

R. Industrial cooperative training

S. Machine shop

INFORMATION SHEET

- T. Photography
- U. Plumbing
- V. Printing
- W. Radio and television
- X. Sheet metal
- Y. Small engine repair
- Z. Tailoring
- AA. Upholstery
- BB. Welding

III. Student requirements for T & I programs

- A. Operate all power tools safely and correctly
- B. Be safety conscious and follow safety regulations
- C. Take instructions readily and follow directions
- D. Be a good citizen
- E. Control temper at all times
- F. Display enthusiasm about work
- G. Exhibit pride in the auto body trade
- H. Practice conservation of materials and man-hours
- I. Be punctual

IV. Occupational outlook facts for auto body repairmen

- A. Job opportunities result each year from the need to replace experienced mechanics who retire or die
- B. The amount of vehicles increases each year creating a need for more trained mechanics to maintain them
- C. Specialization has created more job opportunities and more desirable working conditions

INFORMATION SHEET

V. Employment opportunities for auto body repairmen

  A. Independent auto body shops

  B. New and used car dealerships

  C. Federal, state, and local government vehicle maintenance

  D. Fleet maintenance

  E. Manufacturing companies

  F. Construction companies

VI. Student youth club--Vocational Industrial Clubs of America (VICA)

VII. Reasons for joining VICA

  A. VICA brings together students with common interests so they can exchange ideas, discuss problems, and share common purposes

  B. VICA is the only national organization designed exclusively for trade, industrial, and technical students

  C. VICA offers greater leadership development opportunities

  D. VICA offers prestige and recognition through a national organization

  E. VICA offers opportunities to students through a national program of awards and contests

  F. VICA serves to broaden perspectives through a national magazine and a system of interstate and interclub communications

  G. VICA offers co-curricular activities to give a student more than occupational skill development and to make education and training more meaningful

  H. VICA membership offers an automatic subscription to the national magazine, *VICA,* and to the newsletter, "VICA NEWS"

  I. VICA members receive a membership card as evidence of their rights and privileges as a member

  J. VICA offers purchase of supplies, pins, and other club jewelry, apparel, and banners for its members

VIII. Definition of VICA--A local, state, and national organization made up of students and advisors who are enrolled in or associated with trade and industrial education

ORIENTATION
UNIT I

ASSIGNMENT SHEET #1--PERSONAL INFORMATION SHEET

NAME CLASS

SOCIAL SECURITY NUMBER

HOME ADDRESS

HOME PHONE

PARENT'S NAME (or guardian)

PARENT'S OCCUPATION

PARENT'S BUSINESS PHONE

WHERE CAN YOUR PARENTS BE REACHED IN CASE OF AN EMERGENCY?

FAMILY DOCTOR
DOCTOR'S PHONE NUMBER

LIST SHOP COURSES YOU HAVE HAD

TRADE EXPERIENCE

NAME OF HEALTH INSURANCE COMPANY

NAME TWO OTHER RELATIVES IN PERMANENT RESIDENCE WHO WILL KNOW WHERE YOU WILL BE:

ADDRESS OF RELATIVES

PHYSICAL DISABILITIES:

DO YOU HAVE AN UP-TO-DATE TETANUS SHOT?

HOME HIGH SCHOOL

ADDRESS

ORIENTATION
UNIT I

TEST

1. Define Trade and Industrial Education.

2. Name ten trades for which training is offered in high school programs.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

   i.

   j.

3. List six student requirements for T & I programs.

   a.

   b.

   c.

   d.

   e.

   f.

4. List three facts concerning the occupational outlook for auto body repairmen.

   a.

   b.

   c.

5. Name four employment opportunities for auto body repairmen.

   a.

   b.

   c.

   d.

6. Name the youth club that T & I students may join.

7. List four reasons for joining the T & I youth club.

   a.

   b.

   c.

   d.

8. Define VICA.

9. Complete a personal information sheet.

   (NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)

ORIENTATION
UNIT I

ANSWERS TO TEST

1. Trade and Industrial Education--An organized program of instruction covering desirable knowledges, skills, and attitudes that pertain to any custom trade, service trade, or occupation which is not classified as agricultural, business, technical, professional, or homemaking

2. Any ten of the following

   a. Air conditioning and refrigeration

   b. Aircraft mechanics

   c. Appliance repair

   d. Auto body repair and painting

   e. Auto mechanics

   f. Brick masonry

   g. Cabinetmaking

   h. Carpentry

   i. Commercial art

   j. Cooperative vocational education

   k. Cosmetology

   l. Diesel mechanics

   m. Drafting

   n. Electricity

   o. Electronics

   p. Farm equipment repair

   q. Heavy equipment operation

   r. Industrial cooperative training

   s. Machine shop

t. Photography

u. Plumbing

v. Printing

w. Radio and television

x. Sheet metal

y. Small engine repair

z. Tailoring

aa. Upholstery

bb. Welding

3. Any six of the following

a. Operate all power tools safely and correctly

b. Be safety conscious and follow safety regulations

c. Take instructions readily and follow directions

d. Be a good citizen

e. Control temper at all times

f. Display enthusiasm about work

g. Exhibit pride in the auto body trade

h. Practice conservation of materials and man-hours

i. Be punctual

4. a. Job opportunities result each year from the need to replace experienced mechanics who retire or die

b. The amount of vehicles increases each year creating a need for more trained mechanics to maintain them

c. Specialization has created more job opportunities and more desirable working conditions

5. Any four of the following

a. Independent body shops

b. New and used car dealerships

   c. Federal, state, and local government vehicle maintenance
   d. Fleet maintenance
   e. Manufacturing companies
   f. Construction companies

6. Vocational Industrial Clubs of America (VICA)

7. Any four of the following
   a. VICA brings together students with common interests so they can exchange ideas, discuss problems, and share common purposes
   b. VICA is the only national organization designed exclusively for trade, industrial, and technical students
   c. VICA offers greater leadership development opportunities
   d. VICA offers prestige and recognition through a national organization
   e. VICA offers opportunities to students through a national program of awards and contests
   f. VICA serves to broaden perspectives through a national magazine and a system of interstate and interclub communications
   g. VICA offers co-curricular activities to give a student more than occupational skill development and to make education and training more meaningful
   h. VICA membership offers an automatic subscription to the national magazine, VICA, and to the newsletter, "VICA NEWS"
   i. VICA members receive a membership card as evidence of their rights and privileges as a member
   j. VICA offers purchase of supplies, pins, and other club jewelry, apparel, and banners for its members

8. Definition of VICA--A local, state, and national organization made up of students and advisors who are enrolled in or associated with trade and industrial education

9. Performance skills will be evaluated according to the criteria listed on the progress chart.

SAFETY
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to recognize unsafe situations and be able to state rules for shop and personal safety. He should be able to select the correct fire extinguisher for the classes of fire and match the safety color code with statements of its use. The student should be willing to sign the safety pledge form and should make at least one-hundred percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define the terms safety, accident, and first aid.
2. Match the six colors of the safety color code with statements of their use.
3. List five rules for personal safety.
4. List eight rules for general shop safety.
5. List five methods used to maintain a clean and orderly shop.
6. Match the four classes of fire with statements defining each class.
7. List the three components of the fire triangle.
8. Select from a list of fire extinguishers the types best suited to extinguish each class of fire.
9. Indicate a willingness to work safely by subscribing to the student safety pledge form.

SAFETY
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information sheet and the safety pledge form.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete the safety pledge form.

  D. Take test.

INSTRUCTIONAL MATERIAL

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters:

    1. TM 1--The Fire Triangle

    2. TM 2--Types of Fire Extinguishers

  D. Assignment Sheet #1--Student Safety Pledge Form

  E. Test

  F. Answers to test

II. References:

A. Kidde Portable Extinguishers. *The ABC's of Fire Protection.* Belleville, New Jersey: Walter Kidde and Company, Inc.

B. U.S. Department of Health, Education, and Welfare, Office of Education. *An Accident Prevention Program for School Shops and Laboratories.* Department of Vocational Education, Pennsylvania State University, 1967.

C. U.S. Department of Labor. *Federal Register.* Vol. 36. Number 105. Part II. May 29, 1971.

D. Department of Education, Division of Vocational Education, State of New Jersey. *Safety Practices and Procedures in School Shops.* Trenton, New Jersey: New Jersey State Department of Vocational Education.

SAFETY
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Safety--State or condition of being safe; freedom from danger, risk, or injury

B. Accident--Includes any suddenly occurring, unintentional event which causes injury or property damage

C. First aid Immediate, temporary care given to the victim of an accident or sudden illness until the services of a physician can be obtained

II. Colors and application of the safety color code

A. Federal safety red--The basic color for the identification of:

1. Fire protection equipment and apparatus
2. Portable containers of flammable liquids
3. Emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

B. Federal safety yellow--The basic color for designating:

1. Caution and for marking physical hazards
2 Waste containers for explosive or combustible materials
3. Caution against starting, using, or moving equipment under repair
4. Identification of the starting point or power source of machinery

C. Federal safety orange--The basic color for designating:

1. Dangerous parts of machines
2. Safety starter buttons
3. The exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

D. Federal safety purple--The basic color for designating: radiation hazards

E. Federal safety green--The basic color for designating:

1. Safety

INFORMATION SHEET

2. Location of first aid equipment

   (NOTE: This applies to equipment other than fire fighting equipment.)

F. Federal safety black and white--(used individually or in combination) The basic colors for designating:

   1. Traffic flow

   2. Housekeeping purposes

III. Personal safety rules

   A. Wear shop clothing appropriate to the instructional activity being performed

   B. Confine long hair before operating rotating equipment

   C. Always wear safety glasses; use suitable helmets and goggles for welding

   D. Remove ties when working around machine tools or rotating equipment

   E. Remove rings and other jewelry when working in the shop

   F. Conduct yourself in a manner conducive to safe shop practices

   G. Use soap and water frequently as a method of preventing skin diseases

IV. General safety rules

   A. Keep all hand tools sharp, clean, and in safe working order

   B. Report any defective tools, machines, or other equipment to the instructor

   C. Retain all guards and safety devices except with the specific authorization of the instructor

   D. Operate a hazardous machine only after receiving instruction on how to operate the machine safely

   E. Report all accidents to the instructor regardless of nature or severity

   F. Turn off the power and make certain the machine has stopped running before leaving

   G. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool

   H. Disconnect the power from machine tools before performing the maintenance task of oiling or cleaning

INFORMATION SHEET

   I. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it

   J. Use correct properly fitting wrenches for nuts, bolts, and objects to be turned or held

   K. Keep the shop or laboratory floor clear of scraps and litter

   L. Clean up any spilled liquids immediately

   M. Oily rags or oily waste should be stored in metal containers

   N. Clean the chips from a machine with a brush--not with a rag or the bare hands

   O. Do not use compressed air to clean your person or clothing

V. Methods used to maintain a clean and orderly shop

   A. Arrange machinery and equipment to permit safe, efficient work practices and ease in cleaning

   B. Stack materials and supplies safely or store in proper place

   C. Store tools and accessories safely in cabinets, on racks, or in other suitable devices

   D. Clear working areas and work benches of debris and other hazards

   E. Clean and free floors from obstructions and slippery substances

   F. Free aisles, traffic areas, and exits of materials and other debris

   G. Dispose of combustible materials properly or store in approved containers

   H. Store oily rags in self-closing or spring-lid metal containers

   I. Know the proper procedures to follow in keeping the work area clean and orderly

   J. Keep sufficient brooms, brushes, and other housekeeping equipment readily available

VI. Classes of fires

   A. Class A--Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

   B. Class B--Fires that occur with flammable liquids such as gasoline, oil, grease, paints, and thinners

INFORMATION SHEET

C. Class C--Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

D. Class D--Fires that occur with combustible metals such as magnesium

VII. Components of the fire triangle (Transparency 1)

A. Fuel--Any combustible material

B. Heat--Enough to raise the fuel to its ignition temperature

C. Oxygen--Necessary to sustain combustion

(NOTE: To produce fire these three elements are necessary and must be present at the same time. If any one of the three is missing, a fire cannot be started or, with the removal of any of them, the fire will be extinguished.)

VIII. Types of fire extinguishers (Transparency 2)

A. Pressurized water--Operates usually by squeezing a handle or trigger; used on Class A fires

B. Soda acid--Operates by turning extinguisher upside down; used on Class A fires

C. Carbon dioxide (CO_2)--Operates usually by squeezing handle or trigger; used on Class B and C fires

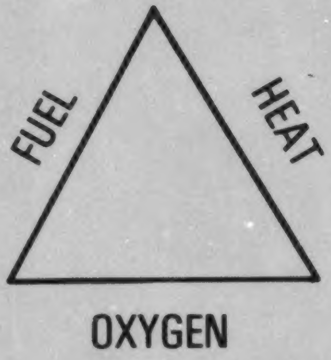
D. Dry chemical--Operates usually by squeezing a handle, trigger, or lever; used on Class B, C, and D fires

(NOTE: On Class D fires, dry sand is as effective as any dry chemical other than Purple X. The cost of the Purple X chemical places it out of reach of most shops.)

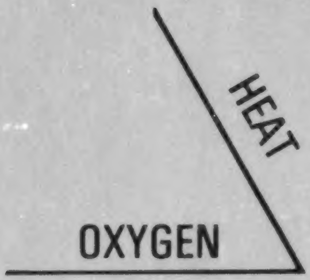
E. Foam--Operates by turning extinguisher upside down; used on Class A and B fires

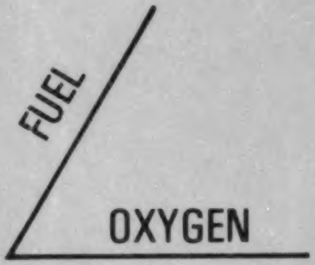
The Fire Triangle

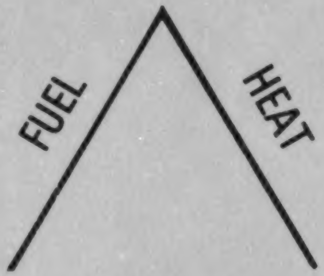
To produce fire, three things must be present at the same time.


FUEL
HEAT
OXYGEN

If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.


HEAT
OXYGEN

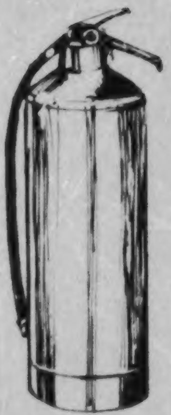

FUEL
OXYGEN



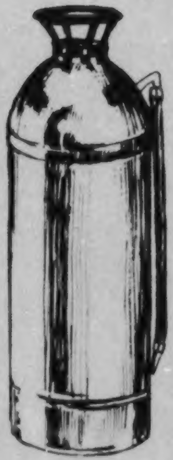
TM 1

25-A·

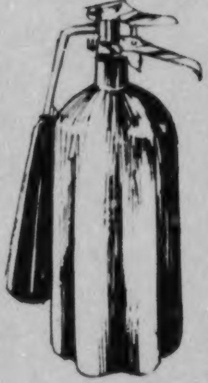
Types of Fire Extinguishers



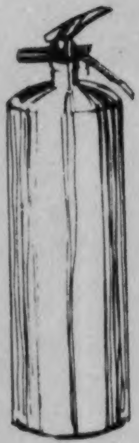
Pressurized
Water



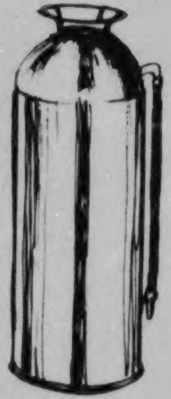
Soda-Acid



Carbon
Dioxide



Dry
Chemical



Foam

SAFETY
UNIT II

ASSIGNMENT SHEET #1--STUDENT SAFETY PLEDGE FORM

___________ ___________ ___________, who is enrolled in Vocational ___________

___________,will as a part of his shop experience, operate machines, providing that his parent or guardian gives written permission.

It is understood that each student will be given proper instruction, both in the use of the equipment and in correct safety procedures concerning it, before being allowed to operate it himself. The student must assume responsibility for following safe practices, and we therefore ask that he subscribe to the following safety pledge.

1. I promise to follow all safety rules for the shop.
2. I promise never to use a machine without first having permission from the instructor.
3. I will not ask permission to use a particular machine unless I have been instructed in its use, and have made 100% on the safety test for that machine.
4. I will report any accident or injury to the teacher immediately.

Date___________Student's signature___________ ___________ _________

I hereby give my consent to allow my son/daughter to operate all machines and equipment necessary in carrying out the requirements of the course in which he is enrolled.

Date___________Parent's signature___________ ___________ __________

Parents are cordially invited to visit the shop to inspect the machines and to see them in operation.

SAFETY
UNIT II

TEST

1. Define the following terms.

   a. Safety--

   b. Accident--

   c. First aid--

2. Match the following colors of the safety color code with the correct statements of their use.

   ______a. Designates caution

   ______b. Used to identify the location of fire fighting equipment

   ______c. Designates the location of safety and first aid equipment

   ______d. Designates dangerous parts of equipment which may cut, crush, shock, or otherwise injure

   ______e. Designates caution against starting equipment while it is being worked on or against the use of defective equipment

   ______f. Designates traffic flow

   ______g. Designates radiation hazards

   1. Green
   2. White
   3. Orange
   4. Purple
   5. Black
   6. Red
   7. Yellow

3. List five personal safety rules.

   a.

   b.

   c.

   d.

   e.

4. List eight rules for general shop safety.

   a.

   b.

c.

d.

e.

f.

g.

h.

5. List five methods used to maintain a clean and orderly shop.

a.

b.

c.

d.

e.

6. Match the classes of fire with the correct statement defining each class.

_____a. Fires that occur with flammable liquids such as gasoline, oil, or grease

_____b. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

_____c. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

_____d. Fires that occur with combustible metals such as magnesium

1. Class A

2. Class B

3. Class C

4. Class D

7. List the three components of the fire triangle.

a.

b.

c.

8. Write the number or numbers of the fire extinguisher best suited to extinguish each class of fire.

   _____a. Fires that occur with flammable liquids such as gasoline, oil, or grease

   _____b. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

   _____c. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

   _____d. Fires that occur with combustible metals such as magnesium

   1. Pressurized water
   2. Carbon dioxide (CO_2)
   3. Dry chemical
   4. Soda acid
   5. Foam

9. Indicate a willingness to work safely by subscribing to the student safety pledge form.

   (NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)

SAFETY
UNIT II

ANSWERS TO TEST

1. a. State or condition of being safe; freedom from danger, risk or injury

   b. Includes any suddenly occuring, unintentional event which causes injury or property damage

   c. Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

2. a. 7

   b. 6

   c. 1

   d. 3

   e. 7

   f. 2 and 5

   g. 4

3. Any five of the following:

   a. Wear shop clothing appropriate to the instructional activity being performed

   b. Confine long hair before operating rotating equipment

   c. Always wear safety glasses; use suitable helmets and goggles for welding

   d. Remove ties when working around machine tools or rotating equipment

   e. Remove rings and other jewelry when working in the shop

   f Conduct yourself in a manner conducive to safe shop practices

   g. Use soap and water frequently as a method of preventing skin diseases

4. Any eight of the following:

   a. Keep all hand tools sharp, clean, and in safe working order

   b. Report any defective tools, machines, or other equipment to the instructor

   c. Retain all guards and safety devices except with the specific authorization of the instructor

- d. Operate a hazardous machine only after receiving instruction on how to operate the machine safely
- e. Report all accidents to the instructor regardless of nature or severity
- f. Turn off the power and make certain the machine has stopped running before leaving
- g. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool
- h. Disconnect the power from machine tools before performing the maintenance task of oiling or cleaning
- i. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it
- j. Use correct properly fitting wrenches for nuts, bolts, and objects to be turned or held
- k. Keep the shop or laboratory floor clear of scraps and litter
- l. Clean up any spilled liquids immediately
- m. Oily rags or oily waste should be stored in metal containers
- n. Clean the chips from a machine with a brush--not with a rag or the bare hands
- o. Do not use compressed air to clean your person or clothing

5. Any five of the following:

- a. Arrange machinery and equipment to permit safe, efficient work practices and ease in cleaning
- b. Stack materials and supplies safely or store in proper place
- c. Store tools and accessories safely in cabinets, on racks, or in other suitable devices
- d. Clear working areas and work benches of debris and other hazards
- e. Clean and free floors from obstructions and slippery substances
- f. Free aisles, traffic areas, and exits of materials and other debris
- g. Dispose of combustible materials properly or store in approved containers
- h. Store oily rags in self-closing or spring-lid metal containers
- i. Know the proper procedures to follow in keeping the area clean and orderly

j. Keep sufficient brooms, brushes, and other housekeeping equipment readily available

6. a. 2

   b. 1

   c. 3

   d. 4

7. a. Fuel

   b. Heat

   c. Oxygen

8. a. 2, 3, and 5

   b. 2 and 3

   c. 1, 4, and 5

   d. 3

9. Evaluated according to the criteria listed on the progress chart.

PAINT AND BODY SHOP SAFETY
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to recognize unsafe situations and state rules for auto body shop and personal safety. He should be able to use the tools and equipment of the trade and accept the responsibilities of body shop safety. This knowledge will be evidenced by scoring one-hundred percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Write in the missing terms in general paint and body shop safety rules.
2. Write in the missing terms in fire or explosion prevention safety rules.
3. Write in the missing terms in paint and body shop rules and equipment safety rules.

PAINT AND BODY SHOP SAFETY
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information sheet.

   C. Discuss terminal and specific objectives.

   D. Discuss information sheet.

   E. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Test

   D. Answers to test

II. References:

   A. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

   B. U.S. Department of Labor. *Federal Register.* vol. 36. number 105. part II. May 29, 1971.

PAINT AND BODY SHOP SAFETY
UNIT III

INFORMATION SHEET

I. General paint and body shop safety rules

   A. Exit must be visible and clearly marked with the letters on the signs at least 3/4" wide and 6" high; the letters on the signs must also be in a contrasting color to the sign background

   B. Protective eye equipment must be worn by all personnel in the removal of mufflers or tail pipes and when using power grinders, polishers, sanders, or doing body work

   C. All power tools, power equipment, and extension cords must be properly grounded

   D. Proper ventilation and air circulation must be provided around all spray painting areas

   E. Paint booths must have explosion proof lights and automatic sprinklers or fire extinguishers and no smoking signs posted

   F. Ear protection must be worn in body shops with noise above ninety decibels

   G. Nonsparking electric motors are used in spray painting areas

   H. No more than 30 psi pressure on air hoses is used to blow dirt off parts

   I. Proper equipment is used to drain and store gas

   J. Goggles and gloves are used in welding and cutting

   K. Approved safety storage containers with flame arrester in spout are used to store thinners, reducers, and flammable cleaners

   L. Painters must wear face masks

   M. All hand tools used must be in good repair and workable condition at all times

   N. Spray finishing operations should be separated from other work areas

   O. No electrical equipment is permitted in any spraying area subject to deposits of combustible residues

   P. Spraying areas must be kept free from the accumulation of deposits of combustible residue

INFORMATION SHEET

Q. Safety shoes should be worn in areas where there is danger of injury by falling or dropping objects

1. Garage area
2. Parts area
3. Storeroom area
4. Paint shop
5. Machine area

R. Gloves should be worn when working with

1. Cleaners
2. Acids
3. Paint and rust removers
4. Grinding
5. Handling sharp edges

S. Eye protection must be worn when

1. Cleaning parts
2. Welding
3. Handling acids and batteries
4. Working beneath vehicles
5. Grinding, polishing, or sanding
6. Doing any machine work
7. Using paint and rust remover

T. Respirators will be used in following areas

1. Painting
2. Grinding or power sanding
3. Any area contaminated with harmful dusts, fogs, fumes, mists, gases, and sprays

INFORMATION SHEET

U. All accidents, regardless of their minority, will be reported to the instructor immediately and first aid will be given when necessary

V. No person other than those enrolled in the course at that hour will be allowed in the shop without a guide and the instructor's permission

W. No one will work overtime in the shop without the instructor's presence

X. Do not work in the shop if you feel ill

Y. Report anything that may lead to an accident

Z. Be sure and ask questions when in doubt

AA. Left-handed students should be extra cautious because most machines are made for right-handed students

BB. Never carry a sharp object like a pencil in your mouth

CC. Do not throw any object within or near the shop

DD. Do not lift heavy objects; secure help

EE. Control your temper and do not take chances

FF. THINK - Machinery cannot

GG. Only authorized personnel will move vehicles

HH. Start vehicle only in neutral and with emergency brake on

II. Do not turn an engine over until helper has given all clear

JJ. Never remove a radiator cap when water is steaming or boiling; when the radiator cools down, remove cap with a rag and stand in the clear

KK. Keep chain hoist hook above head height

II. Fire or explosion prevention

A. Do not overload electrical circuits

B. Do not use frayed or defective electrical cords

C. No electrical repairs will be made by students unless supervised by the instructor

D. Do not weld near gas tanks, fuel lines, lacquer thinner, enamel reducer, paint, or any combustible materials

INFORMATION SHEET

E. Gasoline should be kept and stored in a safety can only

F. If fire cannot be readily extinguished, keep calm and evacuate the shop immediately and turn in alarm

G. No smoking allowed in the shop at any time

H. Batteries must be disconnected when working on or near the electrical system

I. Disconnect battery charger when connecting or removing cable from battery

J. Keep all fire away from charging batteries

K. Do not run over extension or drop cords with jacks or creepers

L. Do not short across the posts on a battery to test its condition

M. Never add water to acid; put acid into the water slowly

N. Do not leave charger on fast charge for very long at one time

O. Do not charge a battery in a small room for very long without sufficient ventilation

P. Handle battery acid carefully and keep it away from the skin and clothing

Q. Be sure charger is switched to six volts position before charging a six volt battery

III. Paint and body shop rules and equipment safety rules

A. Stop a grinder, sander, or buffer while the disc or bonnet is in contact with the surface

B. Start a grinder, sander, or buffer while the disc or bonnet is off the surface

C. Never try to stop a leak in an air hose or hydraulic hose with your hand

D. Never stand in the plane of a pull dozer when pulling

E. Always cover the chain with a canvas or fender cover when pulling with frame equipment

F. Always tighten all pull clamps properly

G. Never heat pull clamp, chains, or in the area of the hydraulic ram

H. Always secure the vehicle properly to frame repair equipment

INFORMATION SHEET

I. Blow out oxygen and acetylene cylinder valves before attaching regulators (crack valve for a moment then close valve)

J. Release adjusting screw on regulator before opening cylinder valve

K. Stand to side of regulator when opening cylinder valve

L. Open cylinder valve slowly

M. Do not use acetylene (in free state) at pressures higher than 15 psi

N. Purge fuel gas and oxygen passages (individually) before lighting torch

O. Light fuel gas before opening oxygen valve on torch

P. Do not use oil on regulators, torches, and fittings

Q. Do not use oxygen as a substitute for compressed air

R. Keep heat, flames, and sparks away from combustibles

S. Wear approved arc welding shields when arc welding or watching other students arc weld

T. Have a fire watcher with the proper extinguishing equipment when any welding or cutting is being performed

U. Do not use any equipment or tools unless properly instructed as to their use

V. Do not use defective tools or equipment

W. Use proper tools and equipment for the proper job

X. Never remove any guard from a machine

Y. Never turn a switch on or off for another person

Z. Use creeper only to work under a vehicle; keep it standing up when not in use

AA. Operate equipment and machines only when authorized to do so by instructor

BB. Never make an adjustment, lubricate, or clean a machine while it is running

CC. Do not distract the attention of a machine operator

DD. Do not clean yourself or anyone else with compressed air

INFORMATION SHEET

EE. Make sure everyone is clear when using compressed air to clean

FF. Do only authorized work in shop

GG. Do not touch belts or pulleys while in motion

HH. Check all equipment before turning on switch

II. Do not work in the dark; use plenty of light

JJ. Report any machine or other equipment that is out of order

PAINT AND BODY SHOP SAFETY
UNIT III

TEST

1. Write in the missing terms for the following general paint and body shop safety rules.

   a. ________________ must be visible and clearly marked with the letters on the signs at least 3/4" wide and 6" high; the letters on the signs must also be in a contrasting color to the sign background

   b. Protective ________________ equipment must be worn by all personnel in the removal of mufflers or tail pipes and when using power grinders, polishers, sanders, or doing body work

   c. All power tools, power equipment, and extension cords must be properly ________________

   d. Proper ________________ and air ________________ must be provided around all spray painting areas

   e. __________ __________ must have explosion proof lights and automatic sprinklers or fire extinguishers and no smoking signs posted

   f. ________________ protection must be worn in body shops with ________________ above ninety decibels

   g. Nonsparking __________ __________ are used in spray painting areas

   h. No more than ________________ psi pressure on air hoses is used to blow dirt off parts

   i. Proper equipment is used to drain and store ________________

   j. ________________ and ________________ are used in welding and cutting

   k. Approved safety storage ________________ with flame arrester in spout are used to store thinners, reducers, and flammable cleaners

   l. Painters must wear __________ __________

   m. All hand tools used must be in good ________________ and ________________ condition at all times

   n. __________ __________ operations should be separated from other work areas

o. No ________________ equipment is permitted in any spraying area subject to deposits of combustible residues

p. Spraying areas must be kept free from the accumulation of deposits of ___________ ___________

q. ___________ ___________ should be worn in areas where there is danger of injury by falling or dropping objects

1) Garage area
2) Parts area
3) Storeroom area
4) Paint shop
5) Machine area

r. ________________ should be worn when working with

1) Cleaners
2) Acids
3) Paint and rust removers
4) Grinding
5) Handling sharp edges

s. ________________ protection must be worn when

1) Cleaning parts
2) Welding
3) Handling acids and batteries
4) Working beneath vehicles
5) Grinding, polishing, or sanding
6) Doing any machine work
7) Using paint and rust remover

t. ________________ will be used in following areas

1) Painting
2) Grinding or power sanding

3) Any area contaminated with harmful dusts, fogs, fumes, mists, gases, and sprays

u. All ________________, regardless of their minority, will be reported to the instructor immediately and first aid will be given when necessary

v. No person other than those enrolled in the course at that hour will be allowed in the shop without a guide and the ________________ ________________

w. No one will work overtime in the shop without the instructor's ________________

x. Do not work in the shop if you feel ________________

y. Report ________________ that may lead to an ________________

z. Be sure and ask ________________ when in doubt

aa. ________________ students should be extra cautious because most machines are made for ________________ students

bb. Never carry a sharp object like a pencil in your ___________

cc. Do not throw any object ________________ or ________________ the shop

dd. Do not ________________ heavy objects; secure help

ee. Control your ________________ and do not take chances

ff. THINK - ________________ cannot

gg. Only ________________ personnel will move vehicles

hh. Start vehicle only in ________________ and with ___________ ___________ on

ii. Do not turn an engine over until ________________ has given all clear

jj. Never remove a ___________ ___________ when water is steaming or boiling; when the ________________ cools down, remove cap with a rag and stand in the clear

kk. Keep ___________ ___________ hook above head height

2. Write in the missing terms for the following fire or explosion prevention safety rules.

a. Do not ________________ electrical circuits

b. Do not use ________________ or ________________ electrical cords

c. No ________________ repairs will be made by students unless ________________ by the instructor

d. Do not ________________ near gas tanks, fuel lines, lacquer thinner, enamel reducer, paint, or any combustible materials

e. Gasoline should be kept and stored in a ________________ can only

f. If ________________ cannot be readily extinguished, keep calm and evacuate the shop immediately and turn in alarm

g. No ________________ allowed in the shop at any time

h. Batteries must be ________________ when working on or near the electrical system

i. ________________ battery charger when connecting or removing cable from battery

j. Keep all ________________ away from charging batteries

k. Do not run over extension or drop cords with ________________ or ________________

l. Do not short across the ________________ on a battery to test its condition

m. Never add water to ________________; put ________________ into the water slowly

n. Do not leave charger on ________________ charge for very long at one time

o. Do not ________________ a battery in a small room for very long without sufficient ventilation

p. Handle battery ________________ carefully and keep it away from the skin and clothing

q. Be sure charger is switched to ________________ volts position before charging a six volt battery

3. Write in the missing terms for the following paint and body shop rules and equipment safety rules.

a. ________________ a grinder, sander, or buffer while the disc or bonnet is in contact with the surface

b. ________________ a grinder, sander, or buffer while the disc or bonnet is off the surface

c. Never try to ________________ a leak in an air hose or hydraulic hose with your ________________

d. Never stand in the ________________ of a pull dozer when pulling

e. Always cover the ________________ with a canvas or fender cover when pulling with frame equipment

f. Always ______________ all pull clamps properly

g. Never ________________ pull clamp, chains, or in the area of the hydraulic ram

h. Always ________________ the vehicle properly to frame repair equipment

i. Blow out oxygen and acetylene cylinder ________________ before attaching regulators (crack valve for a moment then close valve)

j. Release adjusting ________________ on regulator before opening cylinder valve

k. Stand to ________________ of regulator when opening cylinder valve

l. Open cylinder ________________ slowly

m. Do not use ________________ (in free state) at pressures higher than 15 psi

n. ________________ fuel gas and oxygen passages (individually) before lighting torch

o. Light ___________ ___________ before opening oxygen valve on torch

p. Do not use ________________ on regulators, torches, and fittings

q. Do not use ________________ as a substitute for compressed air

r. Keep heat, flames, and sparks away from ________________

s. Wear approved arc welding ________________ when arc welding or watching other students arc weld

t. Have a ___________ ___________ with the proper extinguishing equipment when any welding or cutting is being performed

u. Do not use any ________________ or ________________ unless properly instructed as to their use

v. Do not use ________________ tools or equipment

w. Use proper ________________ and ________________ for the proper job

x. Never remove any ________________ from a machine

y. Never turn a ________________ on or off for another person

z. Use creeper only to work under a vehicle; keep it ________________ ________________ when not in use

aa. Operate equipment and machines only when ________________ to do so by instructor

bb. Never make an ________________, ________________, or ________________ a machine while it is running

cc. Do not distract the ________________ of a machine operator

dd. Do not clean yourself or anyone else with ________________ ________________

ee. Make sure everyone is ________________ when using compressed air to clean

ff. Do only ________________ work in shop

gg. Do not touch ________________ or ________________ while in motion

hh. Check all equipment before turning on ________________

ii. Do not work in the ________________; use plenty of ________________

jj. Report any ________________ or other ________________ that is out of order

PAINT AND BODY SHOP SAFETY
UNIT III

ANSWERS TO TEST

1. a. Exit

b. Eye

c. Grounded

d. Ventilation, circulation

e. Paint booths

f. Ear, noise

g. Electric motors

h. 30

i. Gas

j. Goggles, gloves

k. Containers

l. Face masks

m. Repair, workable

n. Spray, finishing

o. Electrical

p. Combustible residue

q. Safety shoes

r. Gloves

s. Eye

t. Respirators

u. Accidents

v. Instructor's permission

w. Presence

x. Ill

y. Anything, accident

z. Questions

aa. Left-handed, right-handed

bb. Mouth

cc. Within, near

dd. Lift

ee. Temper

ff. Machinery

gg. Authorized

hh. Neutral, emergency brake

ii. Helper

jj. Radiator cap, radiator

kk. Chain hoist

2. a. Overload

b. Frayed, defective

c. Electrical, supervised

d. Weld

e. Safety

f. Fire

g. Smoking
h. Disconnected
i. Disconnect
j. Fire
k. Jacks, creepers
l. Posts
m. Acid, acid
n. Fast
o. Charge
p. Acid
q. Six

3. a. Stop
b. Start
c. Stop, hand
d. Plane
e. Chain
f. Tighten
g. Heat
h. Secure
i. Valves
j. Screw
k. Side
l. Valve
m. Acetylene
n. Purge
o. Fuel gas
p. Oil
q. Oxygen
r. Combustibles
s. Shields
t. Fire watcher
u. Equipment, tools
v. Defective
w. Tools, equipment
x. Guard
y. Switch
z. Standing up
aa. Authorized
bb. Adjustment, lubricate, clean
cc. Attention
dd. Compressed air
ee. Clear
ff. Authorized
gg. Belts, pulleys
hh. Switch
ii. Dark, light
jj. Machine, equipment

Auto Body
PROGRESS CHART

Section A
Introduction

	Unit I Orientation			Unit II General Safety			Unit III Body & Paint Shop Safety													
	1	2	3	1	2	3	1	2	3											
Job	Unit Test	Complete a Personal Information Sheet		Unit Test			Unit Test													
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
85% Correct																		
To Satisfaction of Instructor																		
100% Correct																		
100% Correct																		

VICA
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to name the purposes of the VICA organization. He should be able to write the VICA motto and VICA pledge from memory. He should be able to identify the symbols of the VICA emblem and tell what each represents. He should be able to write what each color of the VICA organization represents and the emphasis of the VICA creed. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Name five purposes of the VICA organization.
2. Write from memory the VICA motto.
3. Write from memory the VICA pledge.
4. Name four beliefs the VICA creed emphasizes.
5. Write what each color of the VICA organization represents.
6. Identify the symbols of the VICA emblem and write what each symbol represents.

VICA
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information sheet.

   C. Make transparency.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency master: TM 1--Symbols of the VICA Emblem

   D. Test

   E. Answers to test

II. Reference: *Official Guide.* Washington, D.C.: Vocational Industrial Clubs of America, Vocational Industrial Clubs of America, Inc., 1025 15th Street N.W., Washington, D.C. 20005.

VICA
UNIT I

INFORMATION SHEET

I. Purposes of the VICA organization

   A. To unite in a common bond all students enrolled in trade and industrial education

   B. To develop leadership abilities through participation in educational, vocational, civic, recreational, and social activities

   C. To foster a deep respect for the DIGNITY OF WORK

   D. To assist students in establishing realistic vocational goals

   E. To help students attain a purposeful life

   F. To create enthusiasm for learning

   G. To promote high standards in trade ethics, workmanship, scholarship, and safety

   H. To develop the ability of students to plan together, organize, and carry out worthy activities and projects through use of the democratic process

   I. To foster a wholesome understanding of the functions of labor and management organizations and a recognition of their mutual interdependence

   J. To create among students, faculty members, patrons of the school, and persons in business and labor a sincere interest in and esteem for trade, industrial, and technical education

   K. To develop patriotism through a knowledge of our Nation's heritage and the practice of DEMOCRACY

II. VICA motto--Preparing for Leadership in the World of Work

III. VICA pledge--UPON MY HONOR, I pledge

   A. To prepare myself by diligent study and ardent practice to become a worker whose services will be recognized as honorable by my employer and fellow workers

   B. To base my expectations of reward upon the solid foundation of service

   C. To honor and respect my vocation in such a way as to bring repute to myself

INFORMATION SHEET

- D. And further, to spare no effort in upholding the ideals of the Vocational Industrial Clubs of America

IV. VICA creed--Emphasizes a belief in

- A. The dignity of work
- B. The American way of life
- C. Education
- D. Fair play
- E. Satisfaction achieved by good work
- F. High moral and spiritual standards

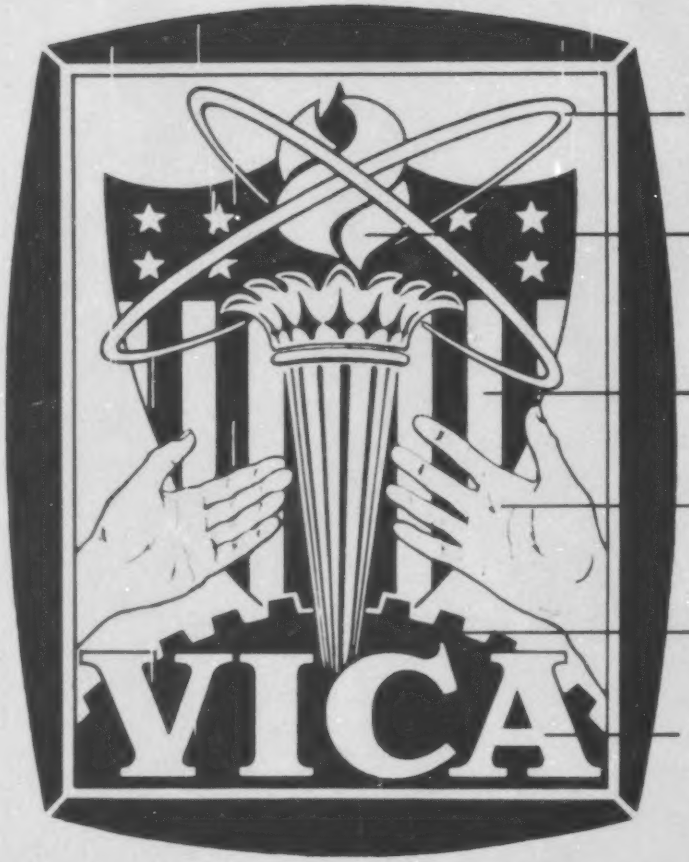
V. Colors of the VICA organization

- A. Red and white--Represent the individual states and clubs
- B. Blue--Represents the common union of the states and of the clubs
- C. Gold--Represents the individual

VI. Symbols of the VICA emblem (Transparency 1)

- A. Shield--Represents patriotism
- B. Torch--Represents knowledge
- C. Orbital circles--Represent technology
- D. Gear--Represents the industrial society
- E. Hands--Represent youth
- F. VICA--Represents Vocational Industrial Clubs of America

Symbols of the VICA Emblem



Orbital Circles Represent Technology

Torch Represents Knowledge

Shield Represents Patriotism

Hands Represent Youth

Gear Represents the Industrial Society

Vocational Industrial Clubs of America

VICA
UNIT I

TEST

1. Name five purposes of the VICA organization.

   a.

   b.

   c.

   d.

   e.

2. Write the VICA motto.

3. Write the VICA pledge.

   Upon my honor I pledge:

   a. To prepare myself--

   b. To base my expectations--

   c. To honor and respect--

   d. And further--

4. Name four beliefs the VICA creed emphasizes.

   a.

   b.

   c.

   d.

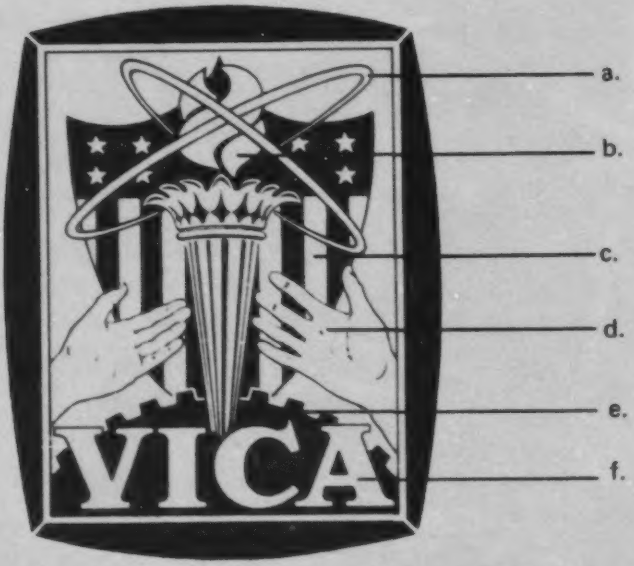
5. Write what each color of the VICA organization represents.

   a. Red and white--

   b. Blue--

   c. Gold--

6. Identify the following symbols and tell what each symbol represents.



a. ______________ Represents ______________________

____

b. ______________ Represents ______________________

____

c. ______________ Represents ______________________

____

d. ______________ Represents ______________________

____

e. ______________ Represents ______________________

____

f. ______________ Represents ______________________

____

VICA
UNIT I

ANSWERS TO TEST

1. Any five of the following

   a. To unite in a common bond all students enrolled in trade and industrial education

   b. To develop leadership abilities through participation in educational, vocational, civic, recreational, and social activities

   c. To foster a deep respect for the DIGNITY OF WORK

   d. To assist students in establishing realistic vocational goals

   e. To help students attain a purposeful life

   f. To create enthusiasm for learning

   g. To promote high standards in trade ethics, workmanship, scholarship, and safety

   h. To develop the ability of students to plan together, organize, and carry out worthy activities and projects through use of the democratic process

   i. To foster a wholesome understanding of the functions of labor and management organizations and a recognition of their mutual interdependence

   j. To create among students, faculty members, patrons of the school, and persons in business and labor a sincere interest in and esteem for trade, industrial, and technical education

   k. To develop patriotism through a knowledge of our Nation's heritage and the practice of DEMOCRACY

2. VICA motto--Preparing for Leadership in the World of Work

3. VICA pledge--UPON MY HONOR, I pledge

   a. To prepare myself by diligent study and ardent practice to become a worker whose services will be recognized as honorable by my employer and fellow workers

   b. To base my expectations of reward upon the solid foundation of service

   c. To honor and respect my vocation in such a way as to bring repute to myself

- d. And further, to spare no effort in upholding the ideals of the Vocational Industrial Clubs of America

4. Any four of the following

   - a. The dignity of work
   - b. The American way of life
   - c. Education
   - d. Fair play
   - e. Satisfaction achieved by good work
   - f. High moral and spiritual standards

5. a. Red and white--Represent the individual states and clubs

   - b. Blue--Represents the common union of the states and of the clubs
   - c. Gold--Represents the individual

6. a. Orbital circles--Represent technology

   - b. Torch--Represents knowledge
   - c. Shield--Represents patriotism
   - d. Hands--Represent youth
   - e. Gear--Represents the industrial society
   - f. VICA--Represents Vocational Industrial Clubs of America

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to apply principles of parliamentary procedure and list characteristics of a good chairman. He should be able to match types of motions with their purpose and list characteristics of motions used in conducting a meeting. He should be able to list purposes of a speech, characteristics of a speech, and write and deliver a speech. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. List two principles upon which parliamentary procedure is based.
2. List three characteristics of a good chairman.
3. Match the types of motions with the appropriate definition.
4. Write the order of business for a meeting.
5. Write the characteristics of the kinds of motions used in conducting a meeting.
6. List three purposes for making a speech.
7. Write the outline most speeches follow.
8. List the three "ups" of speech delivery.
9. Demonstrate the ability to:
    a. Use parliamentary procedure correctly.
    b. Write and deliver a three to five minute speech.

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information sheet.
- C. Discuss terminal and specific objectives.
- D. Have students conduct a business meeting using correct parliamentary procedure.
- E. Have students give speeches.
- F. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Participate in discussion in business meetings and serve as chairman at least once.
- D. Write and deliver a speech.
- E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Test
- D. Answers to test

II. References:

- A. Gray, Jarrell D. *Parliamentary Guide for Vocational Industrial Club of America.* Wolfe City, Texas: Texas Association Inc., Henington Publishing Company.

B. Sturgis, Alice F. *Parliamentary Procedure.* New York: McGraw-Hill Book Company, Inc.

III. Additional materials:

A. "Workbook of Parliamentary Guide for Vocational Industrial Clubs of America," Vocational Industrial Clubs of America, Oklahoma Association. State Department of Vocational and Technical Education, 1515 West Sixth Street, Stillwater, Oklahoma 74074 (15¢). Teachers Key to Workbook, free.

B. Gray, Jarrell D. *Parliamentary Guide for Vocational Industrial Clubs of America.* Texas Association, Inc. (35¢). Order from: Dr. Jarrell D. Gray, Box 717, Commerce, Texas 75428.

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

INFORMATION SHEET

I. Principles upon which parliamentary procedure is based

  A. The right of the majority to rule

  B. The right of the minority to be heard and protected

II. Characteristics of a chairman

  A. Be impartial

  B. Inspire confidence in the members

  C. Provide leadership

III. Types of motions

  A. Main motion

    1. Main idea before the meeting

    2. Only one main motion before the meeting

  B. Amendments--Change a main motion

  C. Motion to reconsider--Close debate

  D. Motion to adjourn--End the meeting

  E. Questions of privilege--Protect rights and comforts of member

  F. Privileged motion

    1. Must be disposed of immediately

    2. Kinds of privileged motions

      a. Adjournment

      b. Call for orders of the day

      c. Fix time of next meeting

  G. Rising to a point of order--Belief of error in procedure

  H. Appeals--Dissatisfaction with a decision of the chair

INFORMATION SHEET

IV. Order of business for a meeting

  A. Opening ceremony

  B. Minutes of previous meeting

  C. Unfinished or old business

  D. Committee reports

  E. New business

  F. Closing ceremony

  G. Entertainment, recreation, refreshments

V. Table of motions and rules that apply to motions

VI. Purposes for making a speech

  A. To inform

  B. To entertain

  C. To persuade

VII. Speech outline

  A. Introduction

  B. Discussion

  C. Conclusion

VIII. Three "ups" of speech delivery

  A. Stand up (avoid leaning on podium)

  B. Speak up

  C. Shut up (short conclusion)

INFORMATION SHEET

V. Table of Motions and Rules That Apply to Motions

Motions	May Interrupt Speaker	Required Second	Debatable	Vote Required	Motion That May Apply
A. Privileged					
1. To fix time	No	Yes	Limited	Maj.	Amend, Reconsider
2. To adjourn	No	Yes	No	Maj.	None
3. To take a recess	No	Yes	Limited	Maj.	Amend
4. Question of privilege	Yes	No	No	Chmn.rules	All
5. Call for order of day	Yes	No	No	None	None
B. Incidental					
1. Point of order	Yes	No	No or Maj.	Chmn.rules	None
2. Appeal	Yes	Yes	Yes	Maj.	All except amend
3. Suspend rules	No	Yes	No	2/3	None
4. Withdraw a motion	No	No	No	Maj.	Reconsider
5. Parliamentary inquiry	Yes	No	No or Maj.	Chmn.rules	None
6. Object to consider	Yes	No	No	2/3	All
7. Call for division of the house	Yes	No	No	Maj.	All
8. To call for a division of a question	No	Yes	No	Maj.	All
C. Subsidiary					
1. Lay on table	No	Yes	No	Maj.	None
2. Previous question	No	Yes	No	2/3	Reconsider
3. Refer to committee	No	Yes	Yes	Maj.	Amend, Recon., Prev. Ques.
4. Amend	No	Yes	Yes	Maj.	Amend, Recon., Prev. Ques.
5. Postpone indefinitely	No	Yes	Yes	Maj.	Limit Deb., Prev. Ques., Recon.
D. Main Motions					
1. General main motion	No	Yes	Yes	Maj.	All
2. Specific main motion					
a. To take from table	No	Yes	No	Maj.	None
b. To reconsider	Yes	Yes	Yes	Maj.	Lim. Deb., Prev. Ques., Table
c. To adopt a resolution	No	Yes	Yes	Maj.	All
d. To adjourn	No	Yes	Limited	Maj.	Amend, Reconsider
e. To create order of day	No	Yes	Yes	Gen.,Maj., Spec. 2/3	All
f. To amend	No	Yes	Yes	Maj.	Amend, Recon., Prev. Ques. Lim. Deb.

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

TEST

1. List two principles upon which parliamentary procedure is based.

   a.

   b.

2. List three characteristics of a good chairman.

   a.

   b.

   c.

3. Match the types of motions with the appropriate definition.

   ______a. To end meeting

   ______b. To close debate

   ______c. Main idea before the group

   ______d. To change the main idea

   ______e. Used when the chair has made an error

   1. Main motion
   2. Amendment
   3. Adjournment
   4. To reconsider
   5. Point of order

4. Write the first three items in the order of business for a meeting.

   a.

   b.

   c.

5. Write the characteristics of motions by filling in the blanks in the following table.

	Second Required	Debatable	Amendable	Vote Required
a. Main motion				
b. Amendment				
c. Adjournment				
d. Lay on table				
e. Point of order				

6. List three purposes for making a speech.

   a.

   b.

   c.

7. Write the outline form that most speeches follow.

   a.

   b.

   c.

8. List the three "ups" of speech delivery.

   a.

   b.

   c.

9. The student should demonstrate the ability to perform the following, to the satisfaction of the instructor.

   a. Use parliamentary procedure correctly.

   b. Write and deliver a three to five minute speech.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

ANSWERS TO TEST

1. a. The right of the majority to rule

   b. The right of the minority to be heard and protected

2. a. Be impartial

   b. Inspire confidence in the members

   c. Provide leadership

3. a. 3

   b. 4

   c. 1

   d. 2

   e. 5

4. a. Opening ceremony

   b. Minutes of previous meeting

   c. Unfinished or old business

5.	a.	Main motion	Yes	Yes	Yes	Majority
	b.	Amendment	Yes	Yes	Yes	Majority
	c.	Adjournment	Yes	No	No	Majority
	d.	Lay on table	Yes	No	No	Majority
	e.	Point of order	No	No	No	None

6. a. To inform

   b. To entertain

   c. To persuade

7. a. Introduction

   b. Discussion

   c. Conclusion

8. a. Stand up (avoid leaning on podium)
   b. Speak up
   c. Shut up (short conclusion)
9. Performance skills will be evaluated according to the criteria listed on the progress chart.

BECOMING A GOOD LEADER
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to name characteristics of a good leader, discuss desirable leadership qualities, and demonstrate an ability to lead others. The student should identify with leadership qualities by taking the Personality Self-Rating Scale. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define leadership.
2. Name five characteristics of a good leader.
3. Discuss in a short paragraph why becoming a good leader is desirable.
4. Name four steps to becoming a good leader.
5. Name five values of having leadership ability.
6. Identify with leadership qualities by taking the Personality Self-Rating Scale.
7. Identify some leaders within the local community and list three factors that identify each as a leader.

BECOMING A GOOD LEADER
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and assignment sheets.

   C. Discuss terminal and specific objectives.

   D. Discuss information and assignment sheets.

   E. Help evaluate the student according to the Personality Self-Rating Scale.

   F. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete assignment sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Assignment sheets

      1. Assignment Sheet #1-Personality Self-Rating Scale

      2. Assignment Sheet #2-Identifying Leaders Within Your Community

   D. Test

   E. Answers to test

II. References:

A. *Official Manual.* Future Farmers of America. Alexandria, Virginia, 1971.

B. Gray, Jarrell D. and J. R. Jackson. *Leadership Training and Parliamentary Procedure for FFA.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958.

C. *Animal Science.* Missouri State Department of Education, Agricultural Education Section, University of Missouri, Columbia, Missouri.

BECOMING A GOOD LEADER
UNIT III

INFORMATION SHEET

I. Leadership--The combination of qualities which inspires confidence, draws others toward the leader, and causes them to follow

II. Characteristics of a good leader

   A. Preparedness--Know leadership takes work as well as practice

   B. Group-mindedness--Regard yourself as a part of the group. Say "we" instead of "I"; do not try to run the crowd. Instead, be guided by the crowd's wishes

   C. Consideration for others--Be understanding and friendly

   D. Poise--Do not let irritations bother you

   E. Humility--Be confident, but not cocky; do not be afraid to reveal you do not know everything

   F. Hard work--Do not ask anyone to do something that you would not be willing to do yourself

   G. Responsibility--Live up to your work and duties

   H. Cooperativeness--Know how to work with others and enjoy working with them

   I. Happiness--Enjoy life; the simple things as well as the big

   J. Imagination--Help the persons in your group to learn and grow through the activities

   K. Preciseness--Be able to express yourself effectively

   L. Pride--Take pride in what you do; take pride in being a leader, but earn it

   M. Neatness--Always be neat in dress and personal appearance

   N. Courtesy--The words "please" and "thank you" pay dividends; use them often

   O. Understanding--Know members' opinions and be ready to meet changing situations

   P. Ambition--Set goals and make them high, but be sure to reach them

INFORMATION SHEET

Q. Open-mindedness--Take advice, but do your own thinking

R. Curiosity--Analyze all the facts before you draw conclusions

S. Energy--Do your best at all times; plan to make the most effective use of your time

III. Reasons to become a good leader

A. Self-satisfaction

B. Leadership needed in all fields

C. Challenge to learn

D. Creates respect for others

E. Aids in maturity

IV. Steps in becoming a good leader

A. Leaders are made, not born

B. Study qualities of a good leader

C. Evaluate weak and strong points of yourself

D. Become a good follower

E. Develop a plan for training yourself as a leader

V. Values of having leadership ability

A. Education

B. Respect

C. Advancement in an occupation

D. Financial betterment

E. Pride

F. Security

BECOMING A GOOD LEADER
UNIT III

ASSIGNMENT SHEET #1--PERSONALITY SELF-RATING SCALE

Circle the appropriate number following each trait. Four is outstanding, three is above average, two is average, one is poor. Total your score below.

1. Do I maintain a well-groomed appearance? 1 2 3 4
2. Do I have a pleasing voice? 1 2 3 4
3. Is my posture alert and poised? 1 2 3 4
4. Is my disposition cheerful? 1 2 3 4
5. Do I make friends easily? 1 2 3 4
6. Do I exert a positive leadership? 1 2 3 4
7. Am I generally thoughtful of the feelings of others? 1 2 3 4
8. Is my enthusiasm sincere and contagious? 1 2 3 4
9. Do I persevere until I achieve success? 1 2 3 4
10. Am I sincere in my interest in other people? 1 2 3 4
11. Am I ambitious to get ahead? 1 2 3 4
12. Do I get along well with others? 1 2 3 4
13. Do I react constructively to criticism? 1 2 3 4
14. Do I remember names and faces? 1 2 3 4
15. Am I punctual on all occasions? 1 2 3 4
16. Do I have and evidence a spirit of cooperation? 1 2 3 4
17. Am I free from prejudice? 1 2 3 4
18. Do I know how people react in most situations? 1 2 3 4
19. Am I generally a good listener? 1 2 3 4
20. Do I refuse to allow what other people say hurt me? 1 2 3 4
21. Can I criticize without giving offense? 1 2 3 4

ASSIGNMENT SHEET #1

22. Do I usually like people for what they are, or do I wait to see if they like me? 1 2 3 4

23. Do I enjoy being part of a group? 1 2 3 4

24. Am I reliable? 1 2 3 4

25. Can I adapt myself to all situations? 1 2 3 4

26. Am I easily discouraged? 1 2 3 4

27. Do I apply myself to the problems of each day? 1 2 3 4

28. Can I make a decision quickly and accurately? 1 2 3 4

29. Am I loyal to my superiors and associates? 1 2 3 4

30. Do I try to get the other fellow's point of view? 1 2 3 4

31. Am I neat and clean in my work as well as my personal appearance? 1 2 3 4

32. Do I know where I make my mistakes, and do I admit them? 1 2 3 4

33. Am I looking for opportunities to serve others better? 1 2 3 4

34. Am I following a systematic plan for improvement and advancement? 1 2 3 4

35. Can I accept honors and advancements and yet keep my feet on the ground? 1 2 3 4

36. Am I playing the game of life honestly and fairly with myself, my fellow members, and others with whom I work? 1 2 3 4

Total Score ____________________

BECOMING A GOOD LEADER
UNIT III

EVALUATION OF ASSIGNMENT SHEET #1

Now to evaluate your scores--If your score totaled over 100, your personality rating is definitely superior and if you have been honest with yourself, you are among the people who are most likely to succeed. 90 - 100 is above average. 75 - 90 is average. Below 75 shows plenty of room for improvement. How did you rate?

BECOMING A GOOD LEADER
UNIT III

ASSIGNMENT SHEET #2 - IDENTIFYING LEADERS WITHIN YOUR COMMUNITY

Identify three individuals in your local community which appear to you as good leaders. After you have identified the leaders, list three factors that identify them as such.

NAME	LEADERSHIP QUALITIES
1. ________________	a. ________________
	b. ________________
	c. ________________
2. ________________	a. ________________
	b. ________________
	c. ________________
3. ________________	a. ________________
	b. ________________
	c. ________________

BECOMING A GOOD LEADER
UNIT III

TEST

1. Define leadership.

2. Name five characteristics of a good leader.

   a.

   b.

   c.

   d.

   e.

3. Discuss in a short paragraph why becoming a good leader is desirable.

4. Name four steps to becoming a good leader?

   a.

   b.

   c.

   d.

5. Name five values of having leadership ability.

   a.

   b.

   c.

   d.

   e.

6. Identify with leadership qualities by taking the Personality Self-Rating Scale.

7. Identify some leaders within the local community and list three factors that identify each as a leader.

(NOTE: If items 6 and 7 have not been accomplished prior to the test, ask the instructor when these activities should be completed.)

BECOMING A GOOD LEADER
UNIT III

ANSWERS TO TEST

1. Leadership--The combination of qualities which inspires confidence, draws others toward the leader, and causes them to follow.
2. Any five of the following
   - a. Preparedness
   - b. Group-mindedness
   - c. Consideration for others
   - d. Poise
   - e. Humility
   - f. Hard work
   - g. Responsibility
   - h. Cooperativeness
   - i. Happiness
   - j. Imagination
   - k. Preciseness
   - l. Pride
   - m. Neatness
   - n. Courtesy
   - o. Understanding
   - p. Ambition
   - q. Open-mindedness
   - r. Curiosity
   - s. Energy
3. Discussion should include the following
   - a. Leadership needed in all fields

   b. Challenge to learn
   c. Creates respect for others
   d. Aids in maturity
   e. Self-satisfaction
   f. Other items that instructor felt was necessary

4. Any four of the following
   a. Leaders are made, not born
   b. Study qualities of a good leader
   c. Evaluate weak and strong points of yourself
   d. Become a good follower
   e. Develop a plan for training yourself as a leader

5. Any five of the following
   a. Education
   b. Respect
   c. Advancement in an occupation
   d. Financial betterment
   e. Pride
   f. Security

6. Evaluated to the satisfaction of the instructor.

7. Evaluated to the satisfaction of the instructor.

APPLYING FOR A JOB
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to locate a job opening, make formal application, and effectively interview for a job. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with a job application to the correct definition.
2. List five means of locating job openings.
3. List three methods of applying for a job.
4. Select ten items of information that may be asked on an application.
5. Select from a list the attributes or attitudes an employer looks for during a personal interview.
6. Identify examples of proper conduct during the job interview.
7. Demonstrate the ability to:
    a. Write a letter of application for a job.
    b. Make an appointment by phone for a job interview.
    c. Write a resume.
    d. Complete an application form for a job.
    e. Write a follow-up letter after an interview for a job.

APPLYING FOR A JOB
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information, assignment, and handout s

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Discuss assignment sheets and handouts.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete assignment sheets and handouts.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Attitudes

    2. TM 2--Take Time To Be On Time

    3. TM 3--Appropriate Dress

D. Assignment sheets

1. Assignment Sheet #1--Write a Letter of Application
2. Assignment Sheet #2--Complete an Application
3. Assignment Sheet #3--Prepare a Resume
4. Assignment Sheet #4--Write a Follow-Up Letter

E. Student handouts

1. Student Handout #1--Application for Employment
2. Student Handout #2--Dear Kid
3. Student Handout #3--Sample Letter of Application
4. Student Handout #4--Sample Resume
5. Student Handout #5--Sample Follow-Up Letter

F. Test

G. Answers to test

II. References:

A. Blackledge - Blackledge - Keily. *You and Your Job.* Dallas, Texas: South-Western Publishing Company, 1967.

B. Milburn, Paul M. *How to Get a Job.* Shawnee, Oklahoma: Gordon Cooper Area Vocational Technical School, 1967.

C. Moynihan - Moynihan - Daeger. *You and Your Job--How to Get It.* Chicago, Illinois: J. G. Ferguson Publishing Company, 1968.

D. Wood - McKeena. *The Receptionist.* Dallas, Texas: Gregg Division, McGraw-Hill Book Company, 1966.

APPLYING FOR A JOB
UNIT IV

INFORMATION SHEET

I. Terms and definitions

  A. Awards--Recognition received for outstanding achievement

  B. Extra-curricular activities--The clubs, organizations, and social or church groups in which one participates

  C. Fringe benefits--The extras provided by an employer such as paid vacations, sick leave, and insurance protection

  D. Qualifications--The experience, education, and physical characteristics which suit a person to a job

  E. Resume--A brief typed summary of one's qualifications and experience that is used in applying for a job

  F. Vocational preparation--Any vocational courses and skills one has learned in high school or through work experience

II. Means of locating a job opening

  A. Classified ads

    1. Newspapers

    2. Magazines

  B. Employment offices

    1. Department of labor

    2. Private

  C. Local labor union business office

  D. School officials

    1. Teacher

    2. Counselor

    3. Principal

  E. Direct contact with employer

INFORMATION SHEET

III. Methods of applying for a job

   A. Letter

   B. Telephone

   C. In person

IV. Information that may be asked on an application (Student Handout #1)

   A. Name and address

   B. Phone number

   C. Social Security Number

   D. Personal information

      1. Age

      2. Sex

      3. Height

      4. Weight

      5. Physical limitations

   E. Education

      1. Elementary

      2. High school

      3. College

      4. Other

   F. Experience (Including military)

   G. Next of kin

   H. Previous employers

   I. Reason for leaving last job

   J. Type of job for which one is applying

   K. References

   L. Resume (optional)

INFORMATION SHEET

V. Personal attributes or attitudes (Transparency 1)

   A. Enthusiasm and interest

   B. Dedication and dependability

   C. Alertness, quickness of mind

   D. Honesty and integrity

   E. Desire to work

   F. Desire to help others

   G. Desire to improve one's self

VI. Proper conduct during the interview (Transparencies 2 and 3; Student Handout #2)

   A. Greet interviewer with a warm smile

   B. Call interviewer by name (Mr., Mrs., or Miss Jones)

   C. Introduce self

   D. Shake interviewers hand firmly

   E. Be seated only after interviewer has asked

   F. Sit and stand erect; do not lean against the wall, a chair, or the desk

   G. Do not put a hat or coat on the interviewer's desk

   H. Let the interviewer take the lead in the conversation

   I. Answer questions completely

   J. Be polite and courteous

      1. Do not interrupt

      2. Say "Yes, sir" or "No, sir"

   K. Have resume and examples of work available for quick reference

   L. Make an extra effort to express one's self clearly and distinctly

      1. Take time to think through every answer

      2. Use proper grammar

INFORMATION SHEET

    3. Do not swear
    4. Avoid use of slang
    5. Try to understand the interviewer's position
    6. Look the interviewer in the eye

M. Be sincere and enthusiastic

N. Avoid irritating or distracting habits:

    1. Smoking, chewing gum, eating candy
    2. Giggling or squirming in chair
    3. Finger tapping and/or swinging a crossed leg

O. Do not try to flatter the interviewer

P. Tell the truth about qualifications and experiences

Q. Speak well of former employers and associates

R. Be positive

S. Accept competition gracefully

T. Watch for a sign that the interview is over

U. Thank interviewer for his time

V. Leave promptly at completion of interview

VII. Writing a letter of application (Student Handout #3)

A. Make sure the letter meets the standards below:

    1. Attractive form
    2. Logical arrangement of information
    3. Free from smudges or typographical errors
    4. Free from spelling or gramatical errors
    5. Brief and to the point--Leave the details for the resume
    6. Positive in tone
    7. Clearly expressed ideas

INFORMATION SHEET

B. The following information should be included in a letter of application

   1. Type of position for which one is applying

   2. Reason interested in position and firm

   3. Ways one's training meets the employer's needs

   4. Explanation of personal qualifications

   5. Mention of resume

   6. Request for interview

      (NOTE: Be sure to include an address and a phone number where you can be reached.)

VIII. Making an appointment by phone for an interview

   A. Steps to follow in making an appointment

      1. Plan what to say before calling

      2. State one's name and reason for calling

         (NOTE: Remember that the receptionist is there to help you. Keep her on your side.)

      3. Ask when would be the best time to come for an interview

         (NOTE: Do not ask over the phone how much the job pays.)

      4. Record the day, time, and place for the interview

      5. Thank the receptionist for her help

         (NOTE: Be polite and courteous. Remember that this is your first contact with the firm. Make that first impression a good one.)

IX. Preparing a resume (Student Handout #4)

   A. Standards for a resume

      1. Logically organized

      2. Neatly typed

      3. Error free

      4. In outline form

INFORMATION SHEET

5. Limited to one page if possible
6. Honest listing of qualifications and experience

B. Information to include in a resume

1. Name, address, and phone number
2. Recent photograph
3. Personal data
    a. Birth date
    b. Age, height, and weight
    c. Physical limitations
    d. Marital status
    e. Hobbies
4. Education
    a. Schools attended
    b. Dates of attendance
    c. Major field of study
    d. Awards and activities
5. Job preferences
6. Experience
    a. Name and address of company
    b. Length of time worked
    c. Brief description of duties and responsibilities
    d. Special training programs or courses
7. References (usually three)

    (NOTE: Be sure to obtain permission before naming someone as a reference.)

INFORMATION SHEET

X. Writing a follow-up letter (Student Handout #5)

A. Make sure this letter meets the following standards:

1. Error free

2. Clean, neat, and arranged attractively

3. Free from spelling, punctuation, and grammatical errors

4. Sent within a day or two after the interview

B. Points to include in a follow-up letter

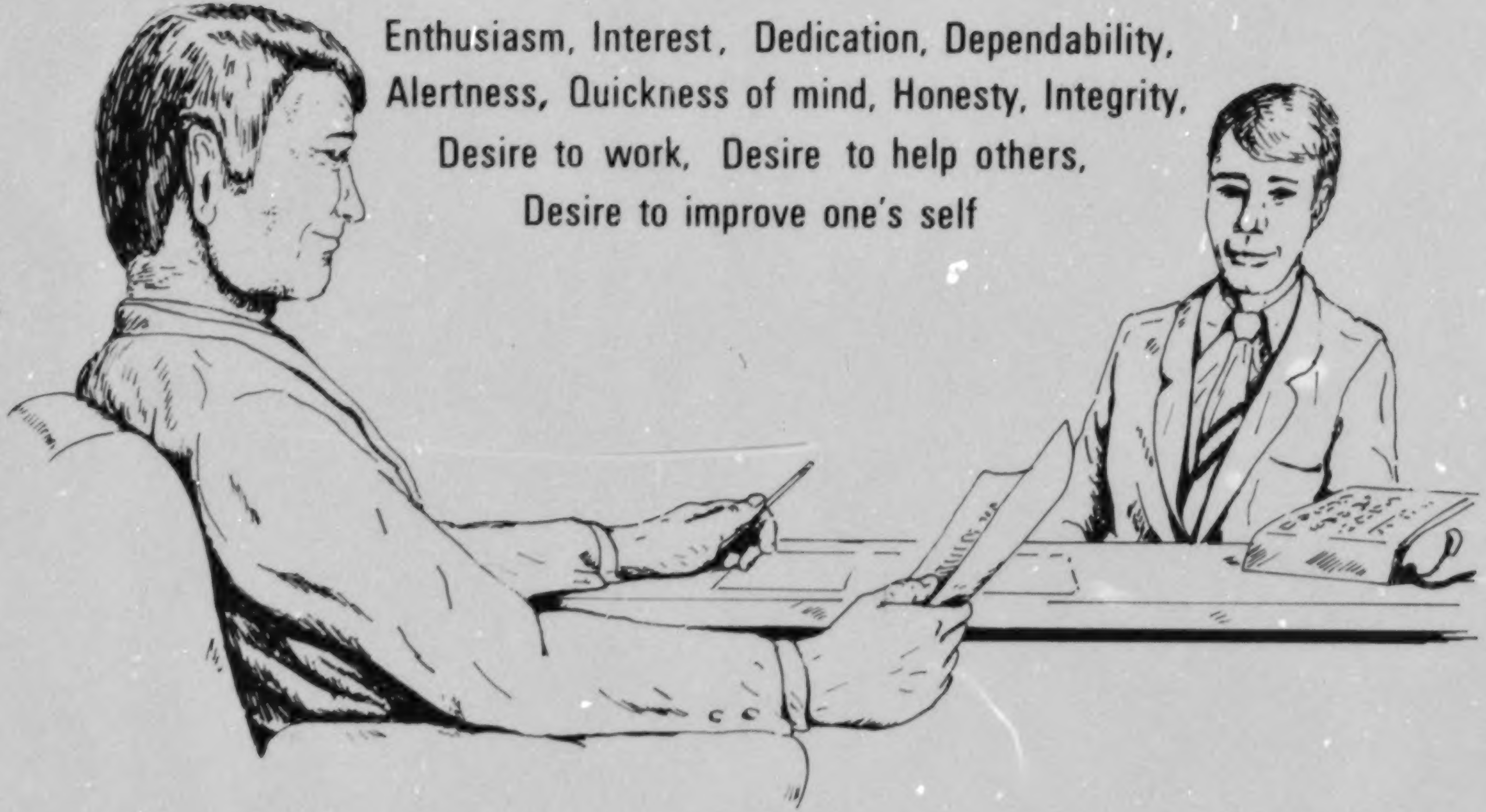
1. An expression of appreciation for the interviewer's time and interest

2. A summary of personal qualifications and interest in the position

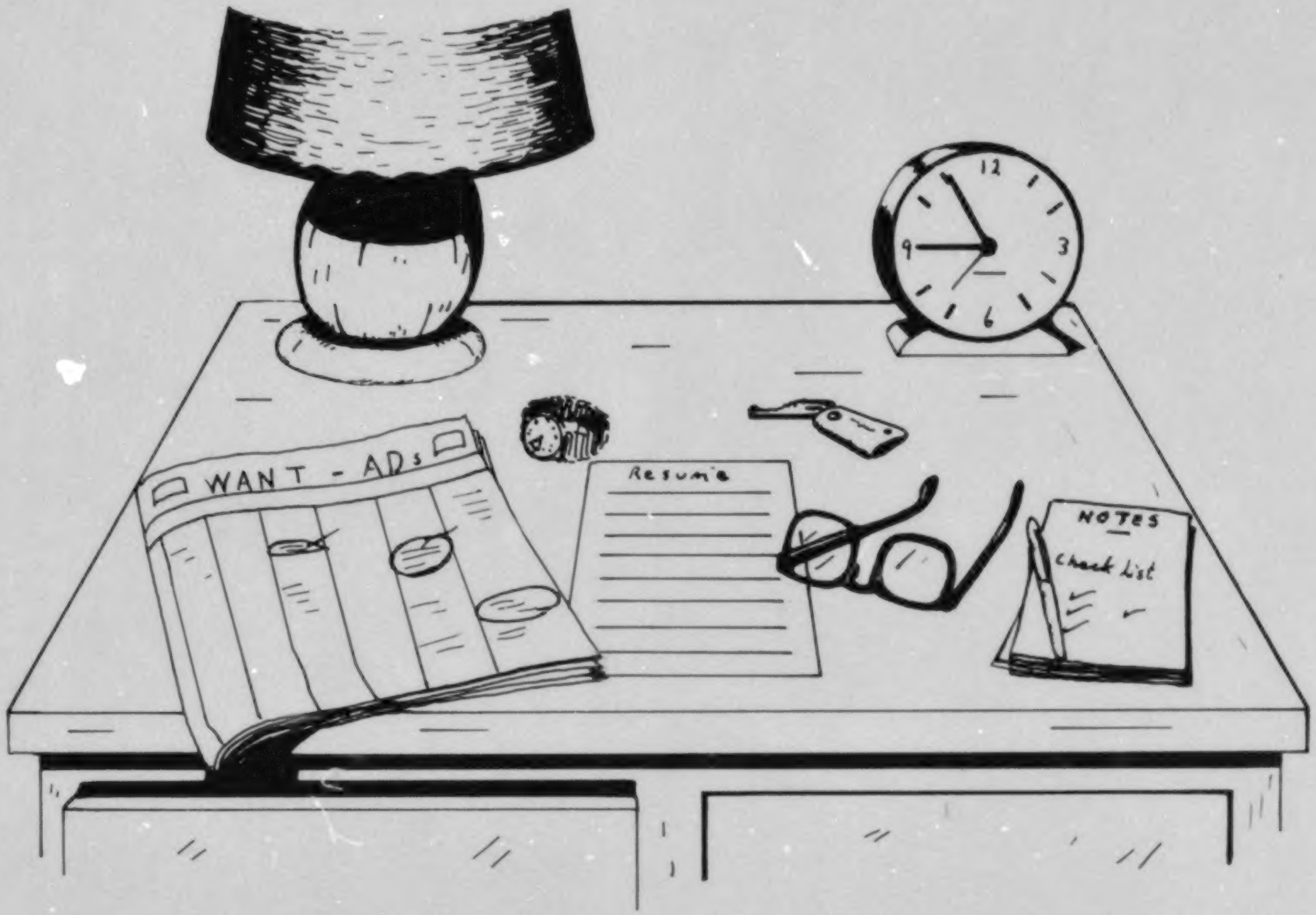
(NOTE: Make this last bid for the job a prime example of your excellent work habits. Make the letter as clean, neat, and well worded as possible.)

Attitudes

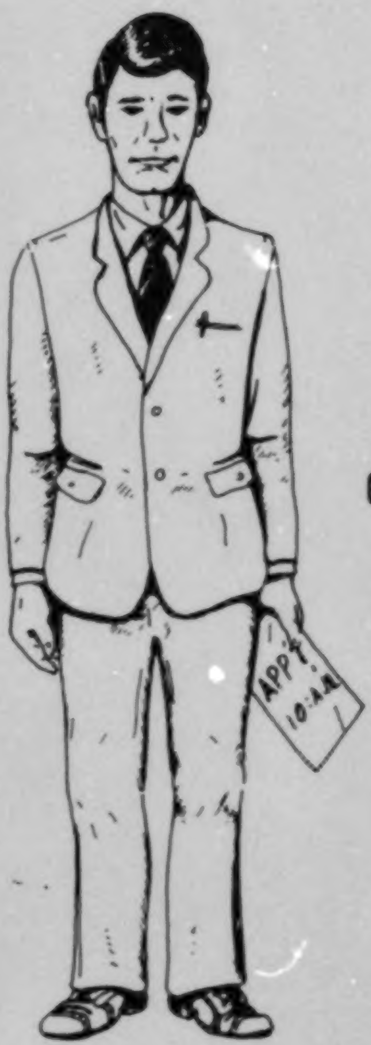
Enthusiasm, Interest, Dedication, Dependability,
Alertness, Quickness of mind, Honesty, Integrity,
Desire to work, Desire to help others,
Desire to improve one's self



Take the Time to be on Time


12
3
6
9
WANT - ADs
Resumé
NOTES
Check List

Appropriate Dress



Hair-neat?

Friendly?

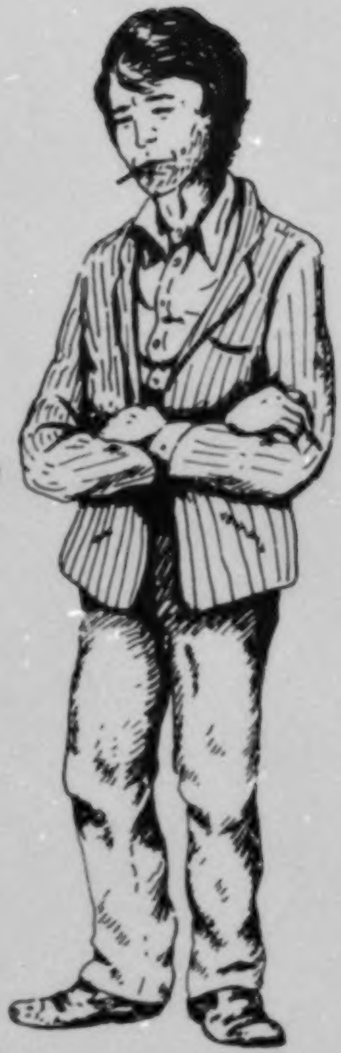
Clean shave?

Clean and neat clothes?

Pen and paper?

On time?

Shoes shined?



APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #1--WRITE A LETTER OF APPLICATION

Directions:

A. Write a letter of application to a prospective employer of your choice. Use the sample letter in Handout #3 as a guide in composing the letter.

B. Make sure the letter meets the standards outlined in the information sheet.

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #2–COMPLETE AN APPLICATION

Directions:

View this form (Handout #1) as an application for employment in the occupation of your choice. Fill in the required information being as honest and realistic as possible.

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #3--PREPARE A RESUME

Directions:

A. Write a resume to be included with a letter of application. Use the example in Handout #4 as a guide.

B. Make sure this resume meets the standards outlined in the information sheet.

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #4--WRITE A FOLLOW-UP LETTER

Directions:

A. Write a follow-up letter to the prospective employer used in Assignment Sheet #1. Use the sample letter in Handout #5 as a guide in composing the letter.

B. Make sure this letter meets the standards outlined in the information sheet.

APPLYING FOR A JOB UNIT IV STUDENT HANDOUT #1

APPLICATION FOR EMPLOYMENT

Do not print

Date ______________________ Position applied for ______________________

Name ______________________ Height ________ Weight ________ Age ________

Address ______________________________ Telephone No. ____________
(Street or RFD) (City) (State)

Previous address ______________________ Social Security No. ____________

Birthdate ______________________ Birthplace ______________________
(Month) (Day) (Year) (City) (State)

CHECK ALL THAT APPLY

____ Female
____ Male
____ Single
____ Married
____ Widowed
____ Divorced
____ Separated

____ Own home
____ Rent
____ Board
____ Live (Parents)
____ With (Relatives)
____ Purchasing home

Number and age of dependents
____
Relationship of dependents
____
Business or occupations of father
____
(or Husband) ______________________

Interested in Temporary work ____ Full time ____ Part time ____ Saturday only ____
Salary expected ______________________
Are you responsible for your entire support? ________ Others who are dependent on you for their support Number ________ Ages ____________
Nature of any physical defects ______________________
Recent illnesses ______________________
Date of last physical examination ______________________

EDUCATION	Circle grade completed	Name of School	Location	Major Subject	Year Graduated
Elementary	1 2 3 4 5 6 7 8				
High	1 2 3 4				
Business or Vocational	1 2 3 4				
College or University	1 2 3 4 5 6				
Night or Correspondence	1 2 3 4				

Give details of any other educational training ______________________
____

STUDENT HANDOUT #1

What are your hobbies? ____________________

In case of illness or emergency, notify: Name ____________________

Address ____________________

Relationship ____________ Telephone ________

Why do you feel qualified for the position for which you are applying?

____

____

____

PREVIOUS EMPLOYMENT

(Last employment first)

From	To	Name & address of employer	Department-position duties - salary	Reason for Leaving
Month Year	Month Year			
Month Year	Month Year			
Month Year	Month Year			
Month Year	Month Year			

PERSONAL REFERENCES

(Do not give names of relatives or former employers)

Name	Address	Occupation
1.		
2.		
3.		

Do Not Write In Space Below

Interviewed by:

Personality ____________________
Attitude ____________________
Ambition and initiative ____________________

Other remarks:

Calmness ____________________
Physical qualities ____________________
Intelligence ____________________
Leadership ____________________
Appearance and grooming ____________________
Work best suited for ____________________

APPLYING FOR A JOB
UNIT IV

STUDENT HANDOUT #2--DEAR KID

Dear Kid:

Today you asked me for a job. From the look of your shoulders as you walked out, I suspect you've been turned down before, and maybe you believe by now that kids out of high school can't find work.

But, I hired a teen-ager today. You saw him. He was the one with the polished shoes and a necktie. What was so special about him? Not experience, neither of you had any. It was his attidude that put him on the payroll instead of you. Attitude son. ATTITUDE. He wanted that job badly enough to shuck the leather jacket, get a haircut, and look in the phone book to find out what this company makes. He did his best to impress me. That's where he edged you out.

You see, Kid, people who hire people aren't "with" a lot of things and we have some Stone Age ideas about who owes whom a living. Maybe that makes us prehistoric, but there's nothing wrong with the checks we sign, and if you want one you'd better tune to our wave length.

Ever hear of "empathy?" It's the trick of seeing the other fellow's side of things. I couldn't have cared less that you're behind in your car payments. That's your problem and the president's. What I needed was someone who'd go out in the plant, keep his eyes open, and work for me like he'd work for himself. If you have even the vaguest idea of what I'm trying to say, let it show the next time you ask for a job. You'll be head and shoulders over the rest.

Look kid. The only time jobs grew on trees was while most of the manpower was wearing G.I.'s and pulling K.P. For all the rest of history you've had to get a job like you get a girl: "Case" the situation, wear a clean shirt, and try to appear reasonably willing.

Maybe jobs aren't as plentiful right now, but a lot of us can remember when master craftsmen walked the streets. By comparison you don't know the meaning of "scarce."

You may not believe it, but all around you employers are looking for young men smart enough to go after a job in the old-fashioned way. When they find one, they can't wait to unload some of their worries on him.

For both our sakes, get eager, will you?

APPLYING FOR A JOB
UNIT IV

STUDENT HANDOUT #3--SAMPLE LETTER OF APPLICATION

Mr. John Jones
Personnel Director
Jones Construction Company
Box 19
Anywhere, U.S.A. 77704

Dear Mr. Jones:

Please consider me for the job of rough framing carpenter that you advertised in the Daily Chronicle.

The skills I have learned in my high school vocational carpentry courses should qualify me for this job. I have had experience in all of the basic skills required in residential construction including the safe use of power tools.

I will be graduating from high school in May, and I would like to become a carpenter. A more complete description of my qualifications is given in the enclosed resume.

May I come for an interview any time at your convenience? I can be reached by phone at 377-3303 after 3:30 p.m. or by mail at 774 East Adams Street, Anywhere, U.S.A. 77704.

Sincerely yours,

James F. Smith

Encl. 1

APPLYING FOR A JOB
UNIT IV

STUDENT HANDOUT #4--SAMPLE RESUME

Name: James L. Smith
Address: 774 E. Adams St., Anywhere, U.S.A. 77704
Telephone: 377-3303

Age: 18 years
Height: 6' - 1"
Weight: 180 pounds
Health: Excellent
Marital Status: Single

Education: Expect to graduate from high school May 1973

Subjects Studied:

Vocational carpentry--2 years (1080 hours)
Algebra--2 semesters
Geometry--2 semesters
Basic drafting--2 semesters
Industrial arts wood working--2 semesters

Student activities:

President, Senior class
President, VICA
Treasurer, Baptist youth fellowship
Carpentry contest, 1st place State, 3rd place National

Work experience:

Carpenter's helper, Jones Construction Co., Summer 1972
Vocational Carpentry Class 1972-73, all phases of construction
Mr. Sammy Slavedriver, Instructor

References:

Mr. Sammy Slavedriver
Vocational Carpentry Instructor
Anywhere High School
Anywhere, U.S.A. 77704

Mr. John Naildriver
Construction Foreman
Jones Construction Company
2330 Lake Shore Drive
Anywhere, U.S.A. 77704

Mr. Jimmie Smith
Youth Director
Park View Baptist Church
711 Fellowship Circle
Anywhere, U.S.A. 77704

Date compiled ____________________

Signature ________________________

APPLYING FOR A JOB
UNIT IV

STUDENT HANDOUT #5--SAMPLE FOLLOW-UP LETTER

Mr. John Jones
Personnel Director
Jones Construction Company
Box 19
Anywhere, U.S.A. 77704

Dear Mr. Jones:

Thank you for interviewing me for the rough framing carpenter job in your firm. I feel that working for Jones Construction Company would be enjoyable and that I could do the general rough framing work that the job requires. I hope that I will have the opportunity to prove my worth.

The application form you gave me is enclosed.

I will be available for work May 15. You may call me at my home after 3:30 p.m. The number is 377-3303.

Sincerely yours,

James L. Smith

encl.

APPLYING FOR A JOB
UNIT III

TEST

1. Match the terms with a job application to the correct definition.

   ______a. A brief typed summary of one's qualifications and experiences that is used in applying for a job

   ______b. The extras provided by an employer such as paid vacations, sick leave, and insurance protection

   ______c. Recognition received for outstanding achievement

   ______d. The experience, education, and physical characteristics which suit a person to a job

   ______e. Any vocational courses and skills one has learned in high school or through work experience

   ______f. The clubs, organizations, and social or church groups in which one participates

   1. Awards
   2. Extra-curricular activities
   3. Fringe benefits
   4. Qualifications
   5. Resume
   6. Vocational preparation

2. List five means of locating job openings.

   a.

   b.

   c.

   d.

   e.

3. List three methods of applying for a job.

   a.

   b.

   c.

4. Select ten items of information that may be asked for on an application.

______a.

______b.

______c.

______d.

______e.

______f.

______g.

______h.

______i.

______j.

1. Race
2. Name and address
3. Phone number
4. Shoe size
5. Age
6. Education
7. Number of brothers and sisters
8. Experience
9. Next of kin
10. Make and model of car
11. Previous employers
12. Reason for leaving last job
13. Are you left or right handed
14. Type of job for which one is applying
15. References

5. Select seven personal attributes or attitudes that an employer looks for.

______a.

______b.

______c.

______d.

______e.

______f.

______g.

1. Alertness
2. Long wavy hair
3. Dedication and dependability
4. Enthusiasm and interest
5. New car
6. Honesty and integrity
7. Desire to work
8. Beard
9. Flashy clothes
10. Desire to help others
11. Desire to improve one's self

6. Identify ten examples of proper conduct during an interview.

_____a.
_____b.
_____c.
_____d.
_____e.
_____f.
_____g.
_____h.
_____i.
_____j.

1. Arrive five minutes late as it gives the impression that one is busy
2. Sit and stand erect
3. Call interviewer by his or her first name
4. Answer questions completely
5. Put a hat or coat on the interviewer's desk
6. Greet interviewer with a warm smile
7. Sit down immediately upon entering the room
8. Shake the interviewer's hand firmly
9. Be polite and courteous
10. Use all of the cute slang expressions
11. Look the interviewer in the eye
12. Be sincere and enthusiastic
13. Thank the interviewer for his time
14. Chain smoke (gives the impression of being a real "he-man")
15. Speak well of former employees
16. Flatter the interviewer
17. Leave promptly at completion of interview

7. Demonstrate the ability to:

a. Write a letter of application for a job.

b. Make an appointment by phone for a job interview.

c. Write a resume.

d. Complete an application form for a job.

e. Write a follow-up letter after an interview for a job.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

APPLYING FOR A JOB
UNIT IV

ANSWERS TO TEST

1. a. 5
   b. 3
   c. 1
   d. 4
   e. 6
   f. 2
2. a. Classified ads
   b. Employment offices
   c. Local labor union business office
   d. School officials
   e. Direct contact with employer
3. a. Letter
   b. Telephone
   c. In person

(IMPORTANT: The answers for 4, 5, and 6 may be given in any order.)

4. a. 2
   b. 3
   c. 5
   d. 6
   e. 8
   f. 9
   g. 11
   h. 12
   i. 14
   j. 15

5. a. 1
   b. 3
   c. 4
   d. 6
   e. 7
   f. 10
   g. 11

6. a. 2
   b. 4
   c. 6
   d. 8
   e. 9
   f. 11
   g. 12
   h. 13
   i. 15
   j. 17

7. Performance skills will be evaluated according to the criteria listed on the progress chart.

Auto Body
PROGRESS CHART

Section B
Related Information

120

	Unit I VICA			Unit II Parliamentary Procedure & Public Speaking			Unit III Becoming A Good Leader			Unit IV Applying for a Job										
	1	2	3	1	2	3	1	2	3	1	2	3	4	5	6	7				
Job	Unit Test			Unit Test	Use Parliamentary Procedure Correctly	Write to Deliver a 3 or 5 Minute Speech	Unit Test			Unit Test	Write a Letter of Application	Make an Appointment by Phone	Write a Resume	Complete an Application Form	Write a Follow-up Letter					
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Auto Body
PROGRESS CHART

Section B
Related Information

Job

	Unit I VICA			Unit II Parliamentary Procedure & Public Speaking			Unit III Becoming A Good Leader			Unit IV Applying for a Job										
	1	2	3	1	2	3	1	2	3	1	2	3	4	5	6	7				
	Unit Test			Unit Test	Use Parliamentary Procedure Correctly	Write to Deliver a 3 or 5 Minute Speech	Unit Test			Unit Test	Write a Letter of Application	Make an Appointment by Phone	Write a Resume	Complete an Application Form	Write a Follow-up Letter					
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

	Accuracy																			
	85% Correct			85% Correct	To Satisfaction of Instructor	To Satisfaction of Instructor	85% Correct			85% Correct	To Satisfaction of Instructor	To Satisfaction of Instructor	To Satisfaction of Instructor	To Satisfaction of Instructor	To Satisfaction of Instructor					
6																				
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CONVENTIONAL AND UNITIZED
BODY AND FRAME CONSTRUCTION
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with conventional and unitized construction and name and identify the parts of the frame and body. He should be able to identify conventional or unitized body construction and the related parts of each. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with conventional and unitized construction to a list of definitions.
2. Name the two types of body panels.
3. List the three sections of a floor panel.
4. Describe the purpose of the wheelhouse panel.
5. List the five panels which make up the front cowl.
6. Name two ways to add rigidity and to prevent excessive vibrations in panels.
7. State the method of fastening inner body panels together.
8. List the five areas where the quarter panels join the various body panels.
9. Identify the components of center post and roof rail construction when given a drawing showing each component.
10. Name the two panels that make up the deck lid.
11. Identify seven panels and three component parts which make up the front end assembly when given a drawing of the parts.
12. Name the two panels which make up the hood.
13. Identify the three sections of a door when given a drawing illustrating each section.
14. Identify the types of frames when given a drawing illustrating each type.
15. Identify the location of body parts when given a drawing illustrating each part.

CONVENTIONAL AND UNITIZED BODY AND FRAME CONSTRUCTION
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information sheet.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Conventional Type Construction

      2. TM 2--Unitized Body Construction

      3. TM 3--Chassis

      4. TM 4--Body to Frame Rubber Insulator

      5. TM 5--Cowl Assembly

      6. TM 6--Quarter Panel Connection Points

7. TM 7--Center Post and Roof Rail Construction
8. TM 8--Front End Assembly
9. TM 9--Parts of a Door
10. TM 10--Types of Frames
11. TM 11--Location of Body Parts

D. Test

E. Answer to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Company of Canada, Limited, 1969.

B. Toboidt, Bill. *Auto Body Repairing and Repainting.* Third Edition. South Holland, Illinois: Goodheart-Willcox Company, Inc., 1972.

CONVENTIONAL AND UNITIZED BODY AND FRAME CONSTRUCTION
UNIT I

INFORMATION SHEET

I. Terms and definitions (Transparencies 1, 2, 3, and 4)

   A. Conventional--Type of frame and body construction where the body and frame are separate units and are bolted together to form the automobile

   B. Unitized--Body design where a separate frame is not used; the body and frame are combined into one unit

   C. Chassis--The engine, drive train, and running gear combined with the frame

   D. Body--The front end assembly combined with the passenger compartment making up the body of the automobile

   E. Copping strips--Formed pieces of metal which are welded to the underside of body panels to add strength

   F. Spot weld--Method used to weld body panels together at the factory; both arc and resistant spot welds are used

   G. Sound deadener--Undercoating or strips of deadening material used to prevent body squeaks, to insulate as a deadening material for outside noise, and to seal body joints

   H. Bumper support--Bumper brackets used to attach the bumper to the body or frame

   I. Torsion bar--Tension bars used in place of springs on some makes of automobiles to aid in lifting and holding up the deck lid and hoods; some makes of cars also use torsion bars for suspension in place of coil or leaf springs

   J. Body-to-frame insulator--Insulator used to cushion the body to the frame at all body bolt areas

   K. Rocker panel--Closed box enclosure along each side of the floor

   L. Weather strip--Rubber strip that seals the openings when hoods, doors, deck lid, and other compartment opening panels are shut to prevent water or dust from entering

II. Types of body panels

   A. Inner panels

   B. Outer panels

INFORMATION SHEET

III. Floor panel sections

- A. Front section
- B. Center section
- C. Rear section

IV. Purpose of wheel housing--To provide a wheel opening for rear wheels, enclose the top of the wheel, and stop objects that are thrown by the tires

V. Front cowl panels (Transparency 5)

- A. Fire wall
- B. Windshield opening frame
- C. Reinforced hinge pillars
- D. Top outer cowl
- E. Dash panel

VI. Ways to add rigidity and prevent excessive vibration in panels

- A. Channels
- B. Beads

VII. Method of fastening inner body panels together--Spot welds

VIII. Areas where quarter panels join body panels (Transparency 6)

- A. Above the deck lid opening to the rear window and parcel shelf
- B. Below the deck lid opening to the lower deck panel
- C. To the wheelhouse panel
- D. To the rear floor pan
- E. At the rear of rocker panel

IX. Components of center post and roof rail construction (Transparency 7)

- A. Roof rail
- B. Drip molding
- C. Center pillar
- D. Rear window header

INFORMATION SHEET

X. Deck lid panels

  A. Outer contour forming panel

  B. Inner reinforcing panel

XI. Front end assembly panels and component parts (Transparency 8)

  A. Fender

  b. Skirt

  C. Tie bar

  D. Stone shield

  E. Radiator support

  F. Shroud

  G. Hood

  H. Radiator

  I. Bumper

  J. Moldings, trim

XII. Hood panels

  A. Hood outer panel

  B. Hood inner panel

XIII. Door sections (Transparency 9)

  A. Outer panel

  B. Door frame

  C. Inner panel

XIV. Types of frames (Transparency 10)

  A. Ladder frame

  B. Hour glass or x frame

  C. Offset frame

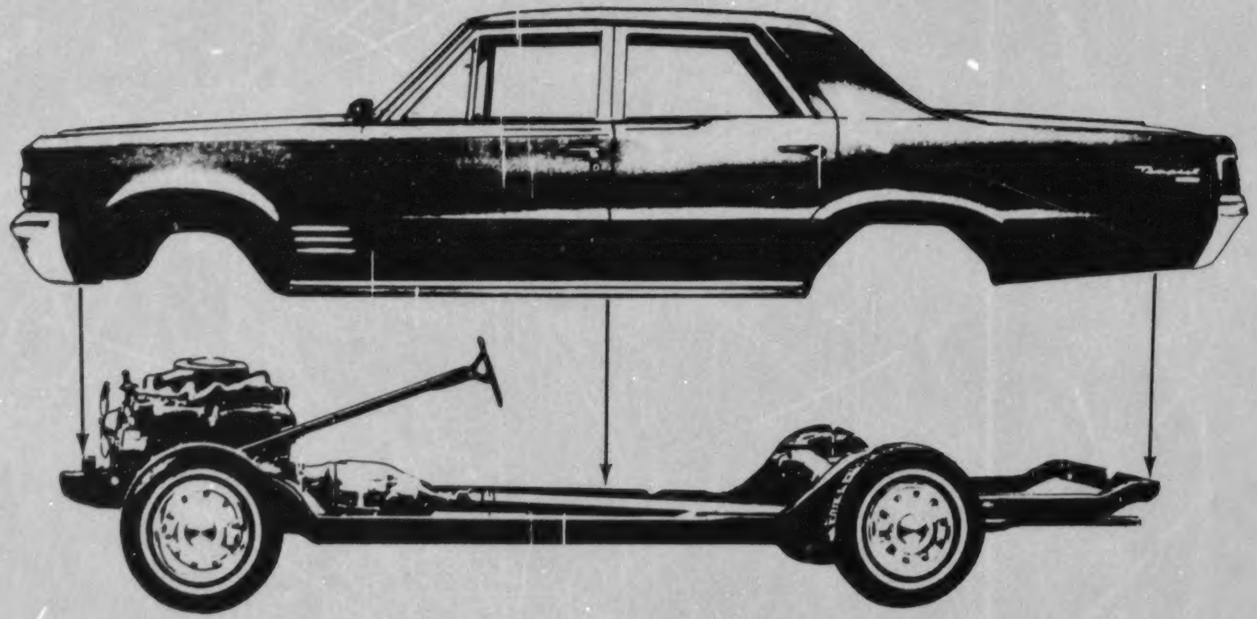
INFORMATION SHEET

    D. Perimeter frame
    E. Unitized frame and body

XV. Body parts (Transparency 11)

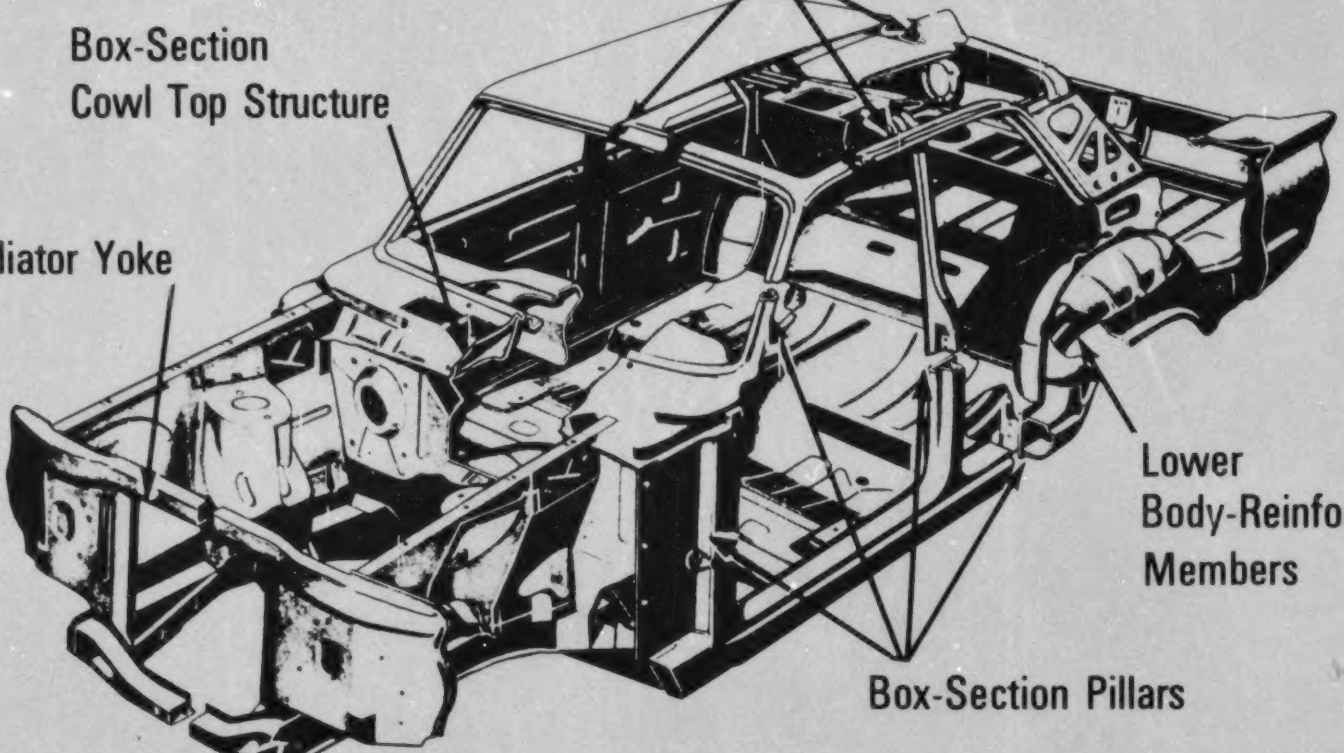
    A. Deck lid
    B. Roof panel
    C. Windshield pillar
    D. Skirt
    E. Grill
    F. Headlight door
    G. Quarter panel
    H. Wheel cover
    I. Ventilator assembly
    J. Rocker panel
    K. Bumper face bar

Conventional Type Construction

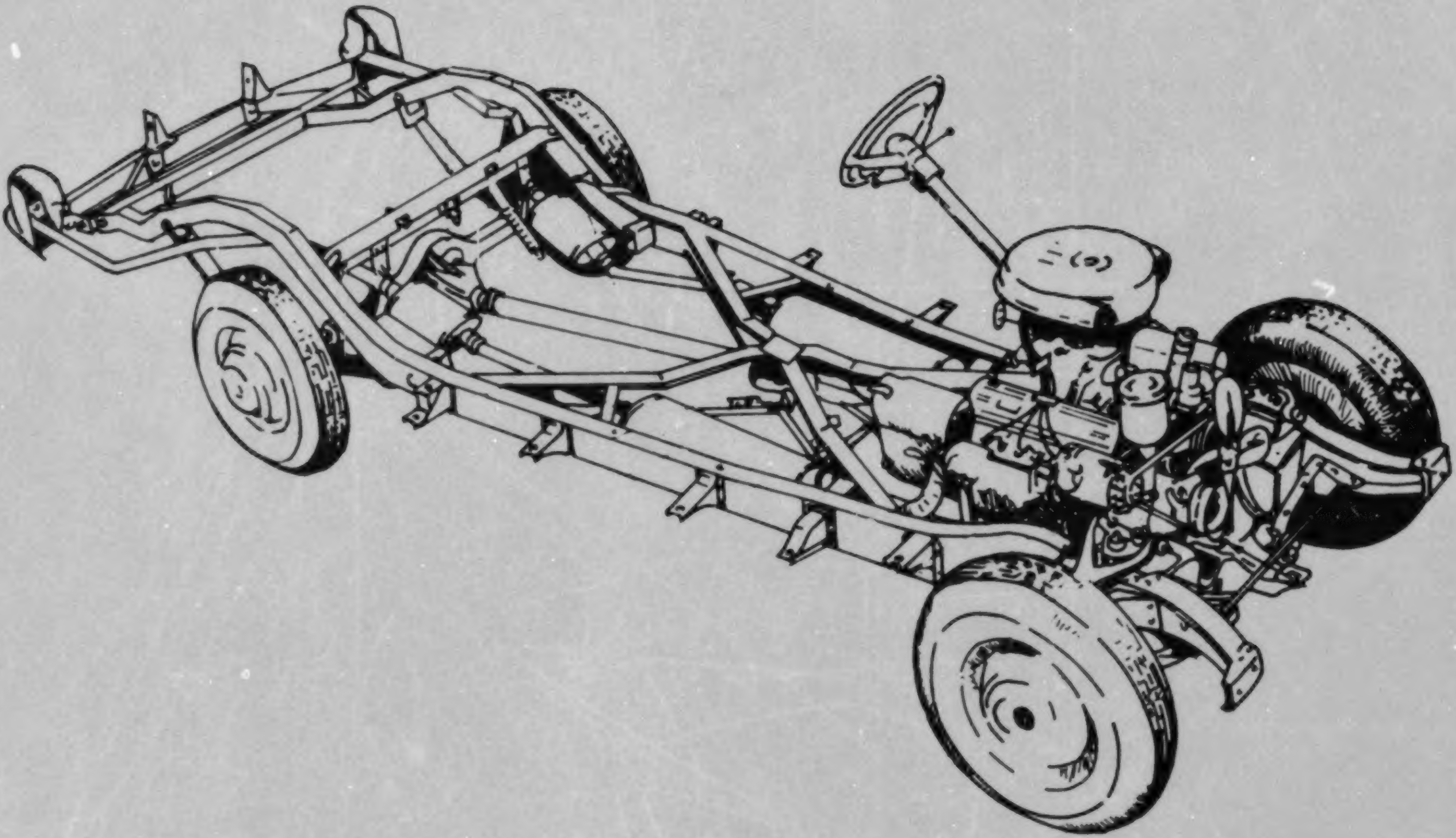


Body-to-Frame

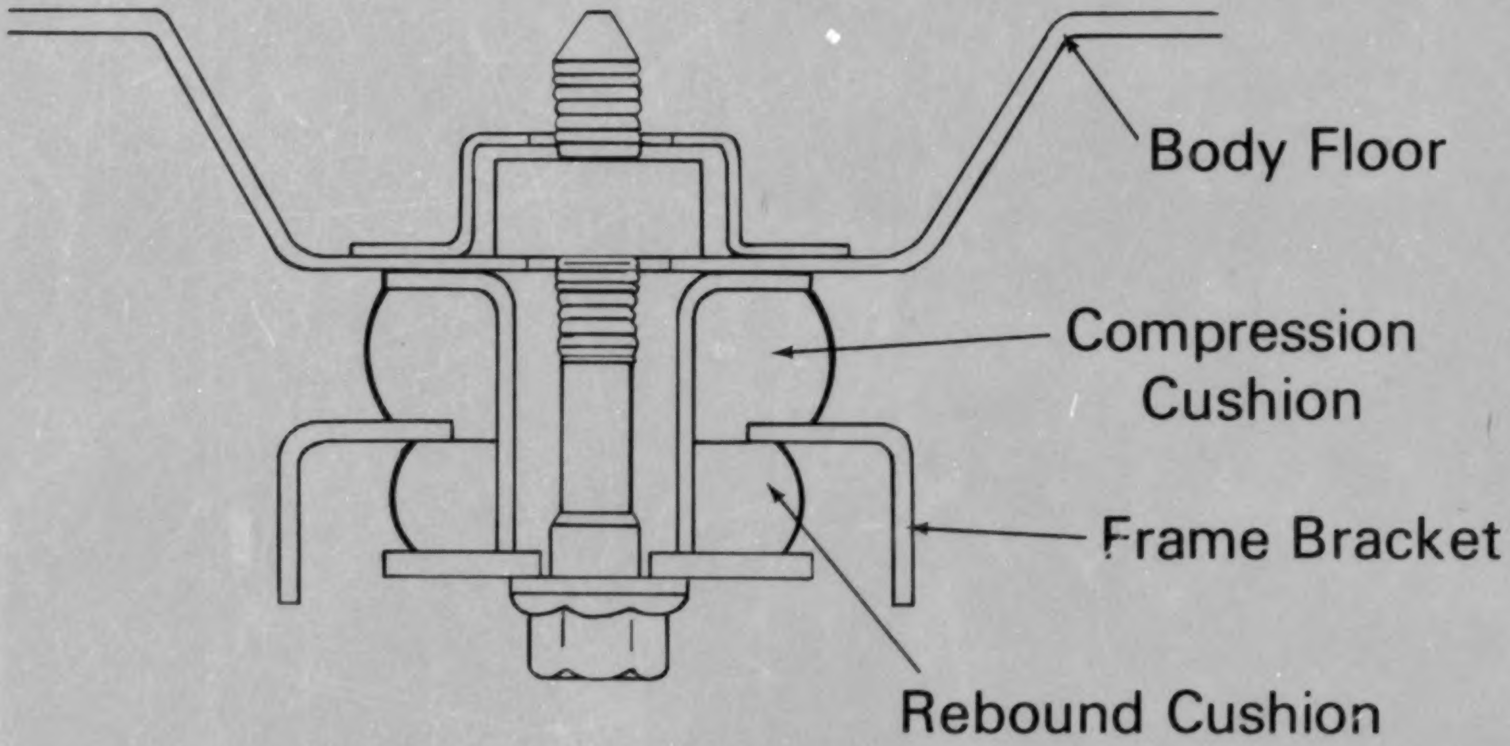
Unitized Body Construction


Box-Section Roof Rails and Headers
Box-Section
Cowl Top Structure
Radiator Yoke
Lower
Body-Reinforcing
Members
Box-Section Pillars
Box-Section Rails

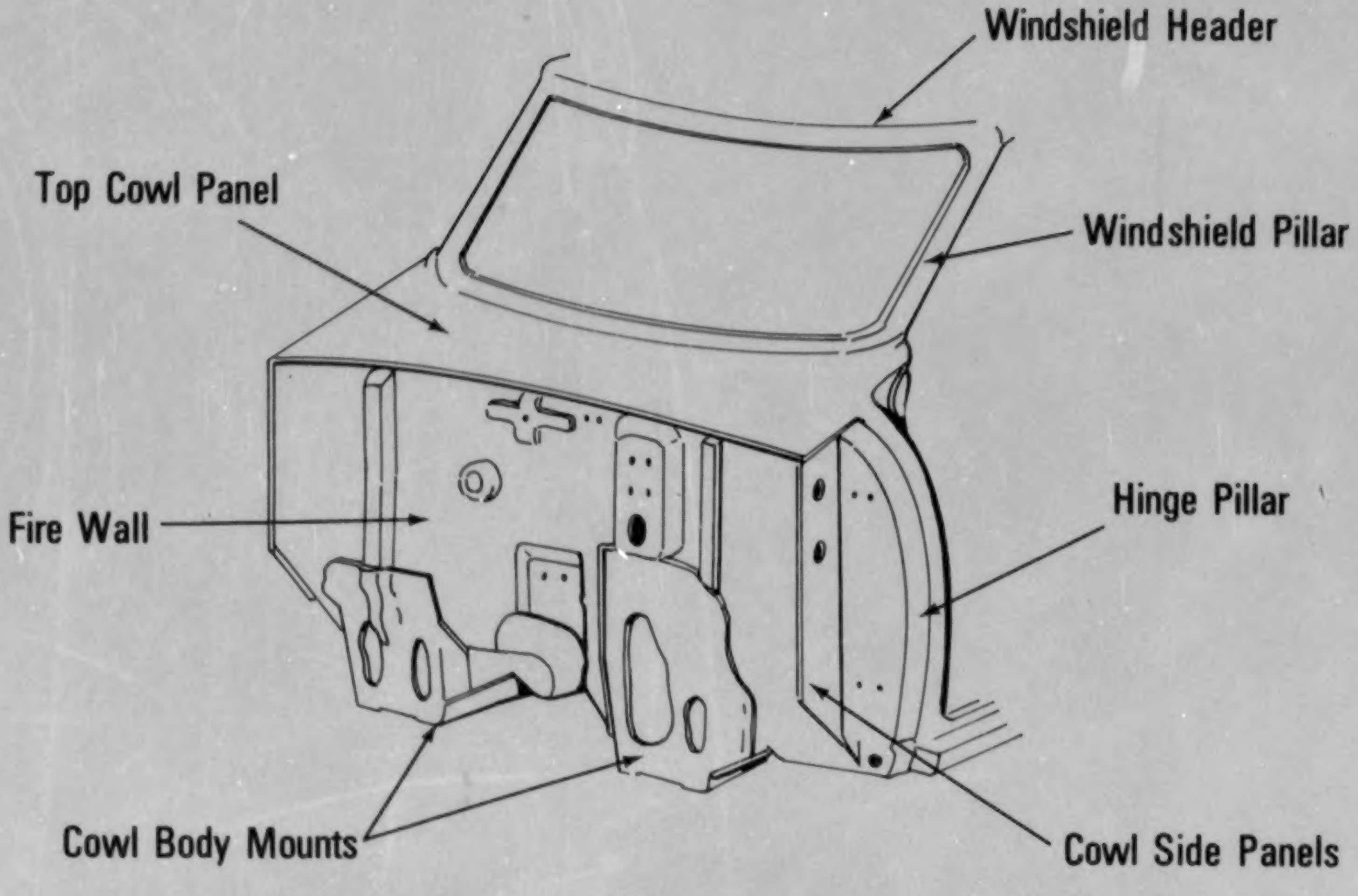
Chassis



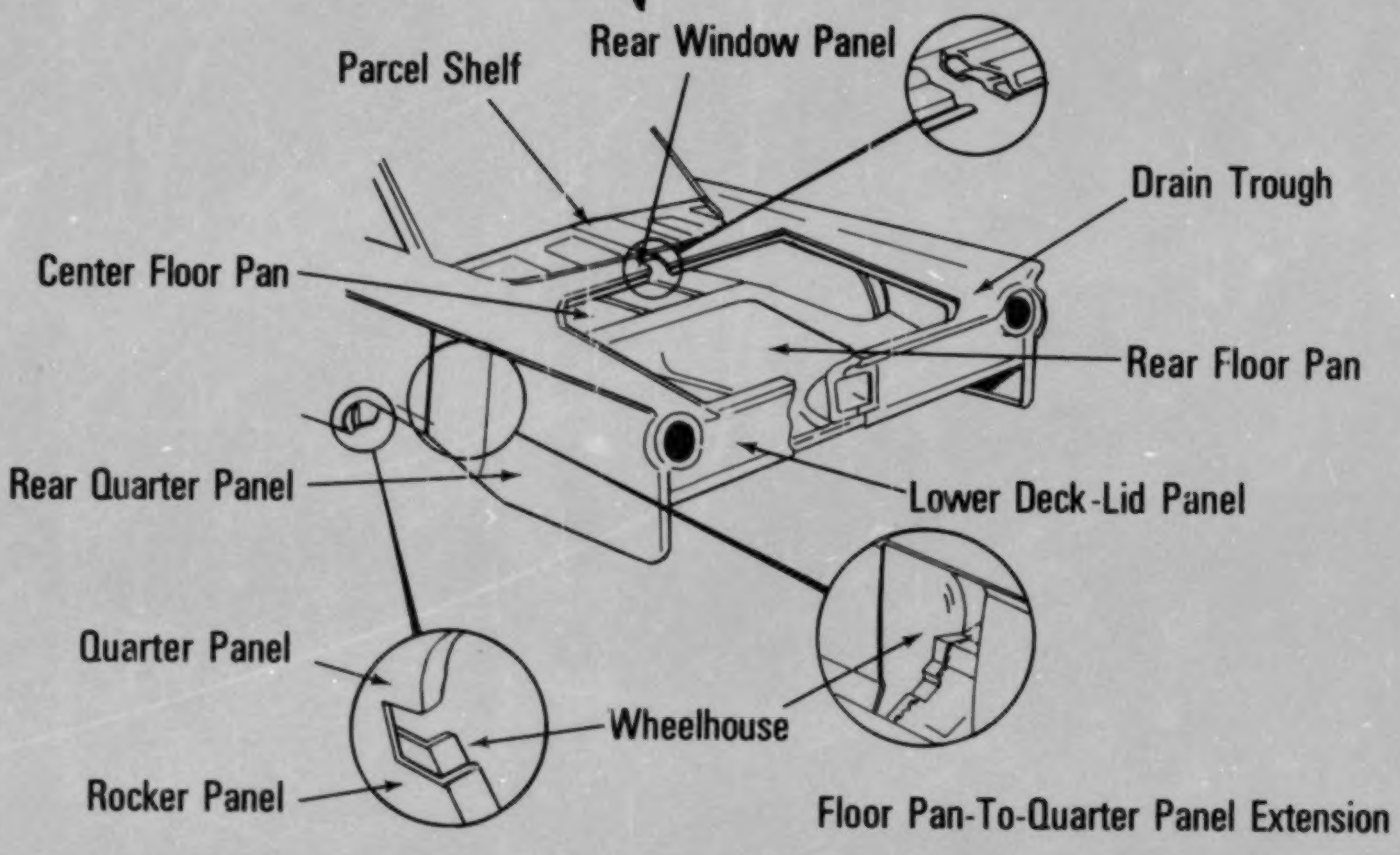
Body to Frame Rubber Insulator


Body Floor
Compression Cushion
Frame Bracket
Rebound Cushion

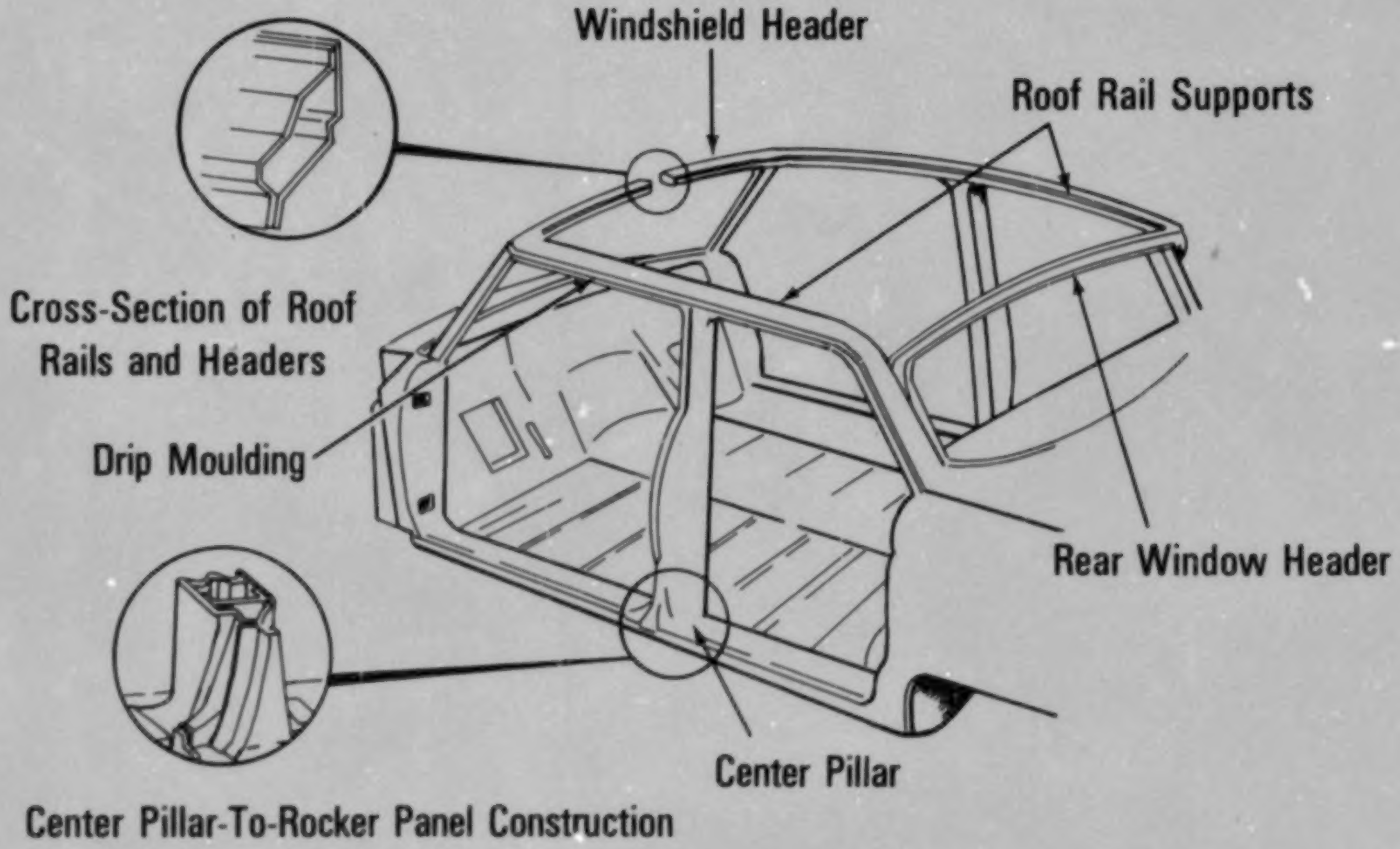
Cowl Assembly


Windshield Header
Top Cowl Panel
Windshield Pillar
Fire Wall
Hinge Pillar
Cowl Body Mounts
Cowl Side Panels

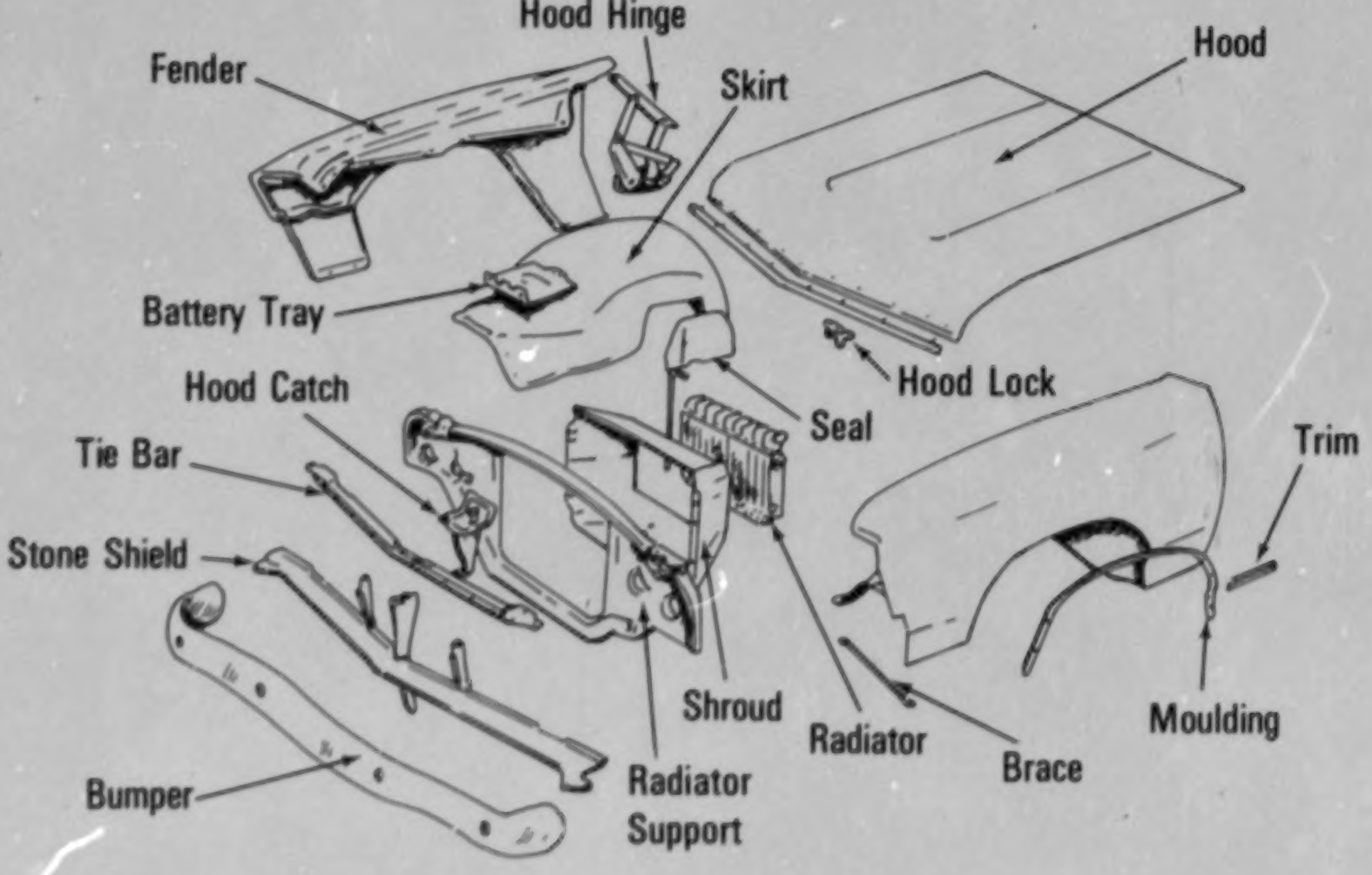
Quarter Panel Connection Points


Parcel Shelf
Rear Window Panel
Drain Trough
Center Floor Pan
Rear Floor Pan
Rear Quarter Panel
Lower Deck-Lid Panel
Quarter Panel
Wheelhouse
Rocker Panel
Floor Pan-To-Quarter Panel Extension

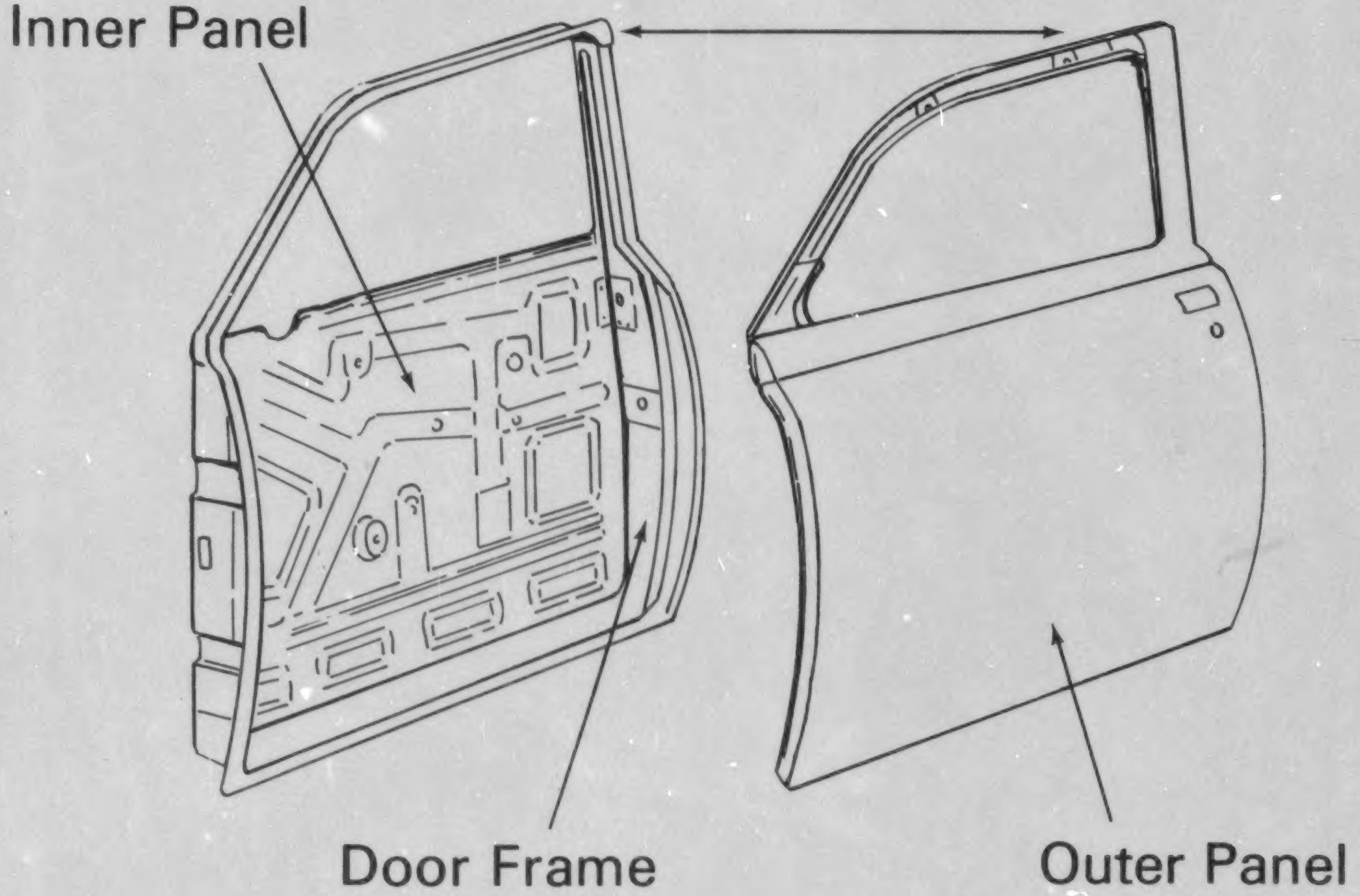
Center Post and Roof Rail Construction


Windshield Header
Roof Rail Supports
Cross-Section of Roof Rails and Headers
Drip Moulding
Rear Window Header
Center Pillar
Center Pillar-To-Rocker Panel Construction

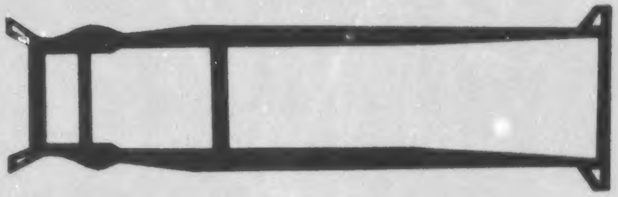
Front End Assembly

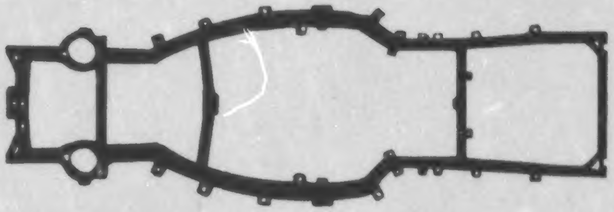

Hood Hinge
Fender
Skirt
Hood
Battery Tray
Hood Lock
Hood Catch
Seal
Trim
Tie Bar
Stone Shield
Shroud
Radiator
Brace
Moulding
Bumper
Radiator Support

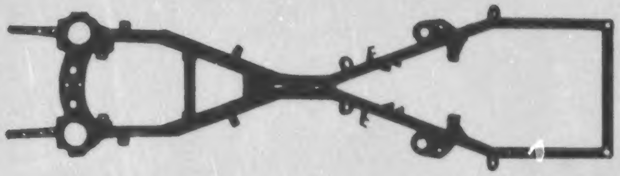
Parts of a Door

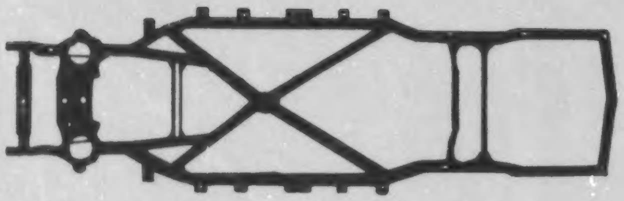

Inner Panel
Door Frame
Outer Panel

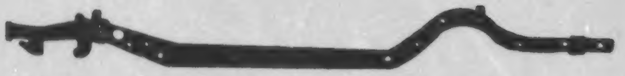
Types of Frames

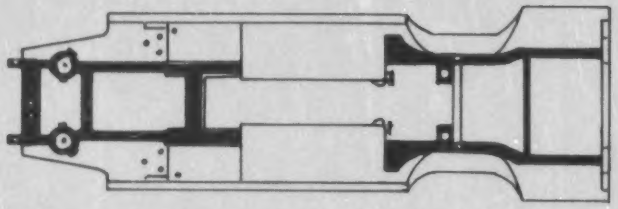

Ladder


Perimeter

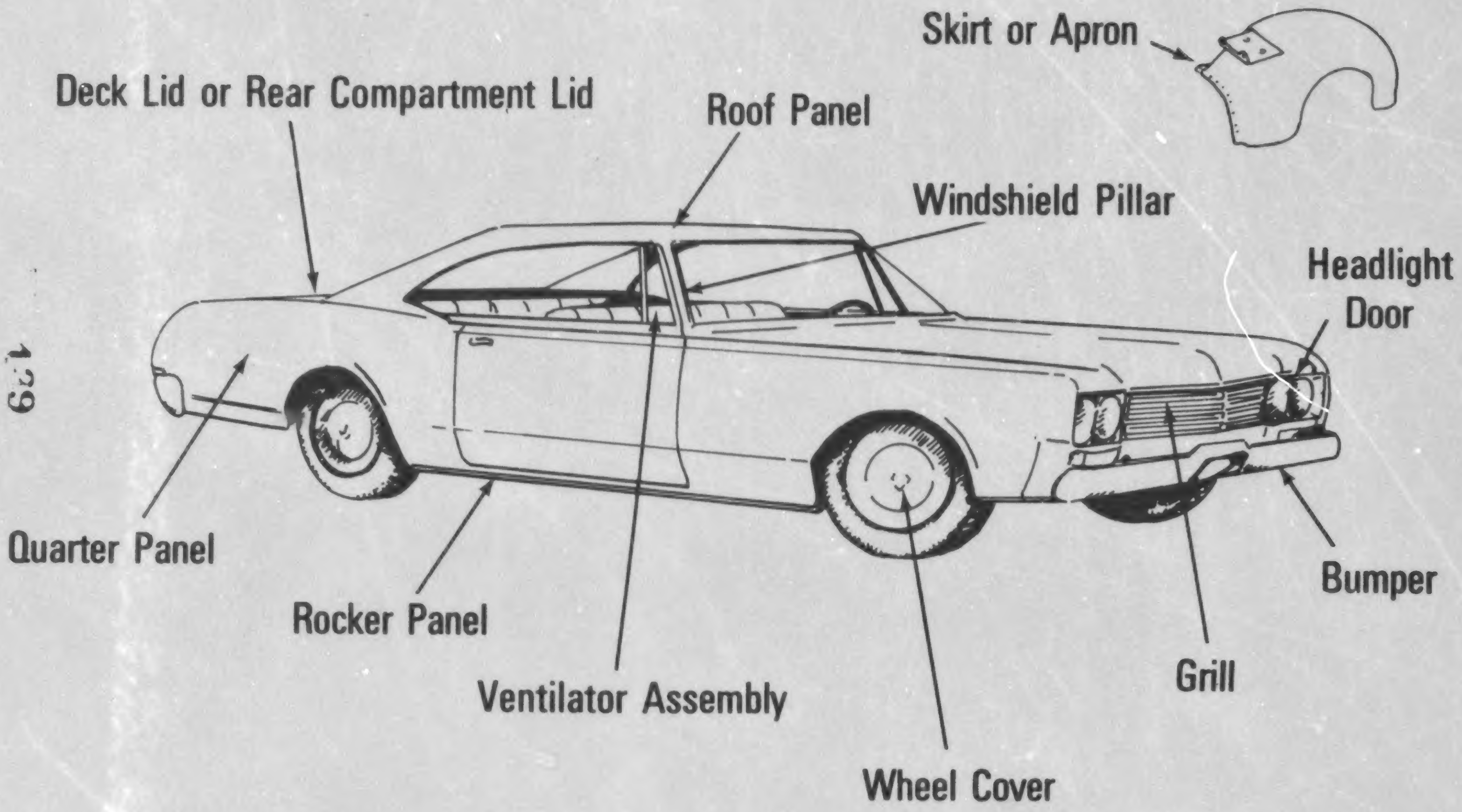

Hour Glass or X Frame


Offset With X Members


Side View of Four Types


Unitized Frame and Body

Location of Body Parts


Skirt or Apron
Deck Lid or Rear Compartment Lid
Roof Panel
Windshield Pillar
Headlight Door
Quarter Panel
Rocker Panel
Ventilator Assembly
Wheel Cover
Grill
Bumper

CONVENTIONAL AND UNITIZED
BODY AND FRAME CONSTRUCTION
UNIT I

TEST

1. Match terms to definitions.

______a. The engine, drive train, and running gear combined with the frame

______b. Insulator used to cushion the body to the frame at all body bolt areas

______c. Formed pieces of metal which are welded to the underside of body panels to add strength

______d. Bumper brackets used to attach the bumper to the body or frame

______e. Type of frame and body construction where the body and frame are separate units and are bolted together to form the automobile

______f. The front end assembly combined with the passenger compartment making up the body of the the automobile

______g. Tension bars used in place of springs on some makes of automobiles to aid in lifting and holding up the deck lid and hoods

______h. Closed box enclosure along each side of the floor

______i. Body design where a separate frame is not used; the body and frame are combined into one unit

______j. Rubber strip that seals the openings when hoods, doors, deck lid, and other compartment opening panels are shut to prevent water and dirt from entering

______k. Method used to weld body panels together at the factory; both arc and resistant welds are used

1. Rocker panel
2. Conventional
3. Unitized
4. Chassis
5. Body
6. Copping strips
7. Spot weld
8. Sound deadener
9. Bumper support
10. Torsion bar
11. Body-to-frame insulator
12. Weather strip

_____l. Undercoating or strips of deadening material used to prevent body squeaks, to insulate as a deadening material for outside noise, and to seal body joints

2. Name two types of body panels.

   a.

   b.

3. List the three sections of a floor panel.

   a.

   b.

   c.

4. Describe the purpose of the wheelhouse panel.

5. List the five panels which make up the front cowl.

   a.

   b.

   c.

   d.

   e.

6. Name two ways to add rigidity and prevent excessive vibration in panels.

   a.

   b.

7. State the method of fastening inner body panels together.

8. List the five areas where the quarter panels join the various body panels.

a.

b.

c.

d.

e.

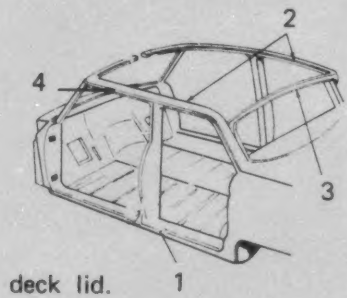
9. Identify components of center post and roof rail construction from the illustration below.

______a. Roof rail

______b. Drip molding

______c. Center pillar

______d. Rear window header



10. Name the two panels which make up the deck lid.

a.

b.

11. Identify the seven panels and three component parts which make up the front end assembly from the illustration given.

______a. Fender

______b. Skirt

______c. Tie bar

______d. Stone shield

______e. Radiator support

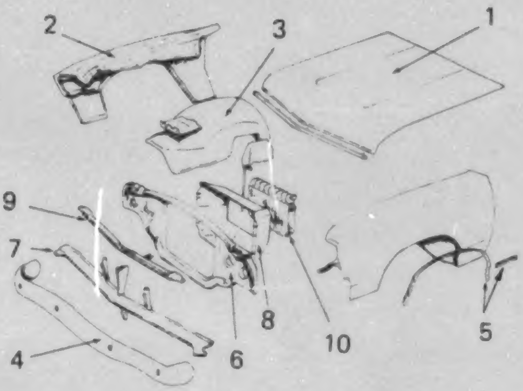
______f. Shroud

______g. Hood

______h. Radiator

______i. Bumper

______j. Molding, trim



12. Name the two panels that make up the hood.

a.

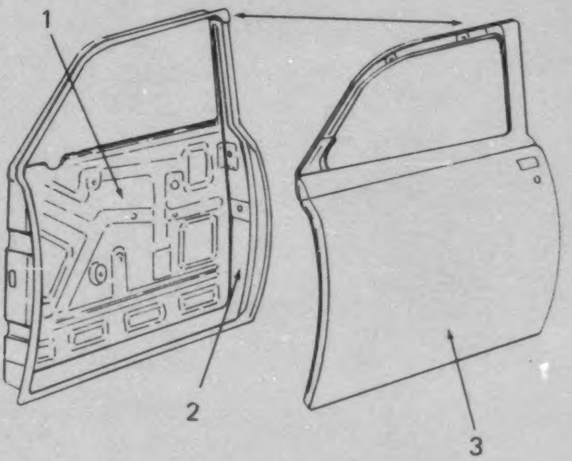
b.

13. Identify the three sections of the door from the illustration given.

______a. Outer panel

______b. Inner panel

______c. Door frame



14. Identify the types of frames.

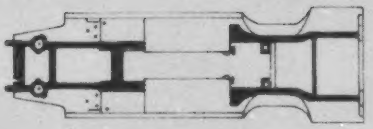
______a. Ladder frame

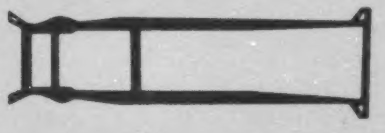
______b. Hour glass or x frame

______c. Offset frame

______d. Perimeter frame

______e. Unitized frame and body


1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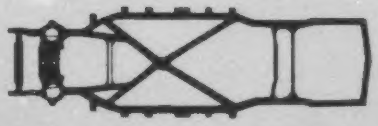
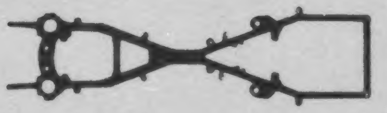
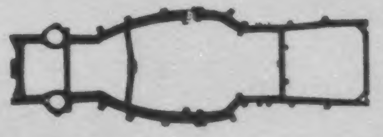

3


4


5

15. Identify the location of body parts.

______a. Deck lid

______b. Roof panel

______c. Windshield pillar

______d. Skirt

______e. Grill

______f. Headlight door

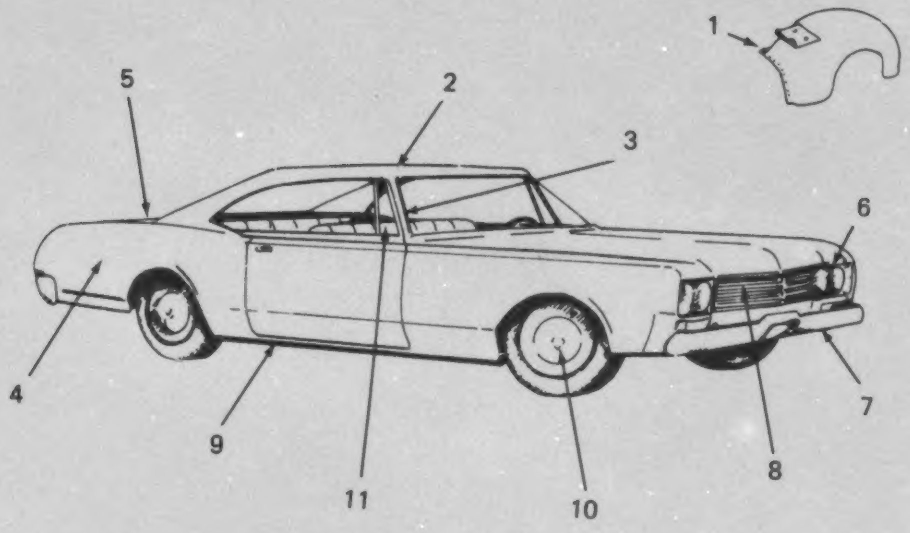
______g. Quarter panel

______h. Wheel cover

______i. Ventilator assembly

______j. Rocker panel

______k. Bumper face bar



CONVENTIONAL AND UNITIZED BODY AND FRAME CONSTRUCTION
UNIT I

ANSWERS TO TEST

1. a. 4
   b. 11
   c. 6
   d. 9
   e. 2
   f. 5
   g. 10
   h. 1
   i. 3
   j. 12
   k. 7
   l. 8
2. a. Inner panels
   b. Outer panels
3. a. Front section
   b. Center section
   c. Rear section
4. To provide a wheel opening for rear wheels, enclose the top of the wheel, and stop objects that are thrown by the tires
5. a. Fire wall
   b. Windshield opening frame
   c. Reinforced hinge pillars
   d. Top outer cowl

e. Dash panel

6. a. Channels

b. Beads

7. Spot welds

8. a. Above deck lid opening to the rear window and panel shelf

b. Below the deck lid opening to the lower deck panel

c. To the wheelhouse panel

d. To the rear floor pan

e. At the rear of rocker panel

9. a. 2

b. 4

c. 1

d. 3

10. a. Outer contour forming panel

b. Inner reinforcing panel

11. a. 2

b. 3

c. 9

d. 7

e. 6

f. 8

g. 1

h. 10

i. 4

j. 5

12. a. Hood outer panel

b. Hood inner panel

13.	a.	3
	b.	1
	c.	2
14.	a.	2
	b.	4
	c.	5
	d.	3
	e.	1
15.	a.	5
	b.	2
	c.	3
	d.	1
	e.	8
	f.	6
	g.	4
	h.	10
	i.	11
	j.	9
	k.	7

Auto Body

PROGRESS CHART

Section C
Body and Frame Construction

	Unit I Conventional & Unitized Body & Frame Construction																			
Job / Unit Test	1	2	3																	
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

	Accuracy 85% Correct																			
4																				
5																				
6																				
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GENERAL HAND TOOLS
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to identify and choose the proper tool for the proper job. He should be able to use all hand tools properly, grind straight blade screwdrivers, dress chisels and punches, and sharpen drill bits. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

1. Identify fifty-two general hand tools.
2. Describe the method for determining the size of a straight blade screwdriver.
3. Identify a six point and a twelve point socket.
4. Name the two ways of measuring nuts and bolts in the automotive industry.
5. List four socket drives that are common to the automotive industry.
6. Tell how many teeth of a hacksaw blade should be in contact with the surface at all times.
7. Name four grades of coarseness files can have.
8. Name two types of cuts that all four grades of files can have.
9. Name three uses of a cold chisel.
10. Identify three main sections of a drill bit.
11. Identify the parts that make up the body of a drill bit.
12. Tell how the size of a hammer is determined.
13. Demonstrate the ability to:
    a. Grind a straight blade screwdriver.
    b. Dress a flat chisel and a punch.
    c. Sharpen a drill bit.
    d. Use all hand tools safely and correctly.

GENERAL HAND TOOLS
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Hand Tools

    2. TM 2--Hand Tools (Continued)

    3. TM 3--Hand Tools (Continued)

    4. TM 4--Hand Tools (Continued)

   5. TM 5--Hand Tools (Continued)
   6. TM 6--Hand Tools (Continued)
   7. TM 7--Six Point and Twelve Point Sockets
   8. TM 8--Types of Files and Cuts
   9. TM 9--Drill Bit Sections
   10. TM 10--Drill Bit Parts

D. Job sheets

   1. Job Sheet #1--Grind a Straight Blade Screwdriver
   2. Job Sheet #2--Dress a Flat Chisel and a Punch
   3. Job Sheet #3--Sharpen a Twist Drill Bit

E. Test

F. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada, Ltd., 1969.

B. McPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Book Co., Inc., 1971.

C. Sargent, Robert L. *Automobile Sheet Metal Repair,* Second Edition. Philadelphia, Pennsylvania: Chilton Book Co., 1969.

D. Spicer, Edward D. *Automotive Collision Work,* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

GENERAL HAND TOOLS
UNIT I

INFORMATION SHEET

I. General hand tools (Transparencies 1, 2, 3, 4, 5, and 6)

  A. Standard screwdriver
  B. Phillips screwdriver
  C. Clutch head screwdriver
  D. Offset screwdriver
  E. Screw starter
  F. Scratch awl
  G. Cotter pin puller
  H. Screw extractor
  I. Chisel
  J. Punch
  K. Pry bar
  L. Tapered reamer
  M. Combination pliers
  N. Diagonal pliers
  O. Lineman pliers
  P. Rib joint pliers
  Q. Needle nose pliers
  R. Hose clamp pliers
  S. Snap ring pliers
  T. Standard grip pliers
  U. Chain wrench pliers
  V. "C" clamp pliers

INFORMATION SHEET

W. Sheet metal pliers
X. Welding clamp pliers
Y. Pipe wrench
Z. Tin snips
AA. Ratchet wrench
BB. Adjustable wrench
CC. Ratchet
DD. Socket
EE. Extention
FF. Break over handle
GG. Speed handle
HH. Hand impact driver and torx bit
II. End wrench
JJ. Box end wrench
KK. Combination end wrench
LL. File
MM. Ball peen hammer
NN. Rubber mallet
OO. Tire tool
PP. Carbon brush
QQ. Wire brush
RR. Drill bit
SS. Tap and die
TT. Vise
UU. Cruncut tool

INFORMATION SHEET

VV. Putty knife

WW. Soldering gun

XX. Measuring tape

YY. Oil can

ZZ. Hacksaw

II. Method for determining the size of a straight blade screwdriver--Determined by the combined length of the shank and blade; blade width and thickness are proportioned to the diameter and length of the shank

III. Six point and twelve point sockets (Transparency 7)

A. Six point socket--Designed to take a firm grip on a six side nut or bolt; it should always be used on brass or soft-metal nuts and bolts

B. Twelve point socket--Easier to get on and off and allows for easy repositioning when handle movement distance is short

IV. Ways of measuring nuts and bolts in the automotive industry

A. The North American automobile industry uses the inch and millimeter to measure nuts and bolts

B. European industry uses the metric

V. Common socket drives of the automotive industry

A. 1/4 drive or midget drive

B. 3/8 drive

C. 1/2 drive

D. 3/4 drive

VI. Number of teeth in a hacksaw blade that should be in contact with the surface at all times--At least two teeth should be in contact with the surface

VII. Grades of file coarseness (Transparency 8)

A. Smooth

B. Second-cut

INFORMATION SHEET

   C. Bastard

   D. Coarse-cut

VIII. Types of file cuts

   A. Single-cut

   B. Double-cut

IX. Uses of a cold chisel

   A. To cut metal

   B. To break spot welds

   C. To split nuts

X. Main sections of a drill bit (Transparency 9)

   A. Shank

   B. Body

   C. Point

XI. Parts that make up the body of a drill bit (Transparency 10)

   A. Flute

   B. Margin

   C. Body clearance

   D. Web

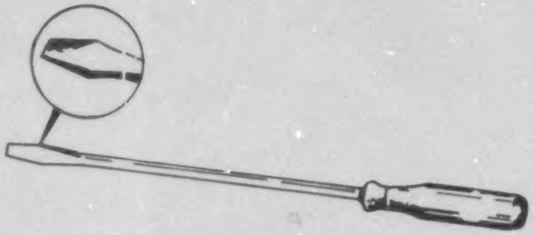
   E. Lip

   F. Heel

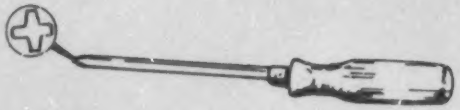
   G. Center

XII. Hammer size--Determined by the weight of the hammerhead

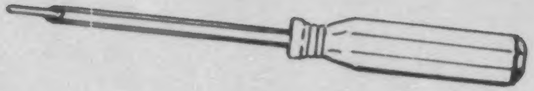
Hand Tools



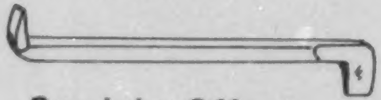
Standard Screwdriver



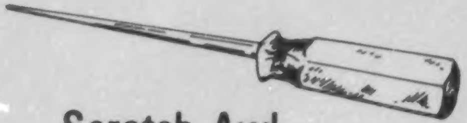
Phillips Screwdriver



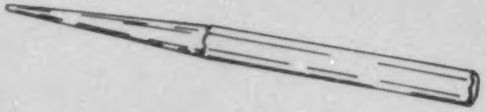
Clutch Head Screwdriver



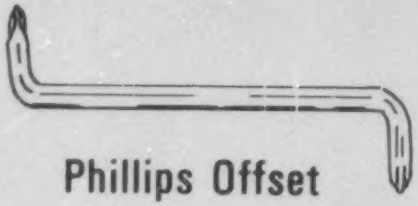
Straight Offset



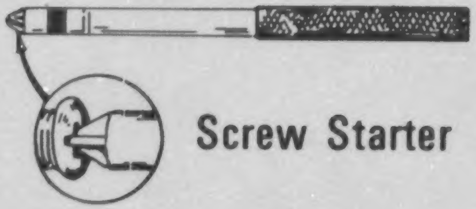
Scratch Awl



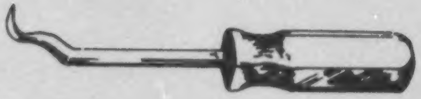
Punch



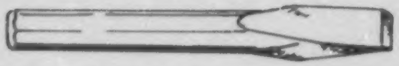
Phillips Offset



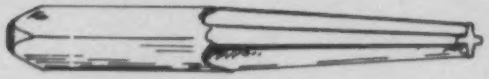
Screw Starter



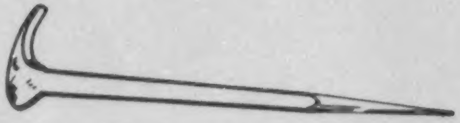
Cotter Pin Puller



Cold Chisel



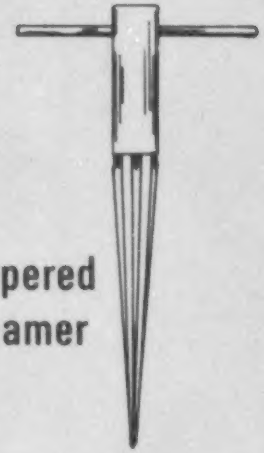
Screw Extractor



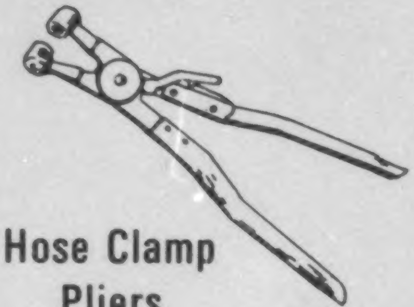
Pry Bar

Hand Tools

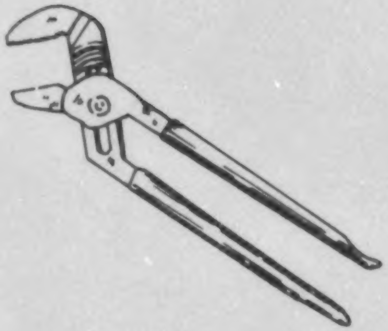
(Continued)



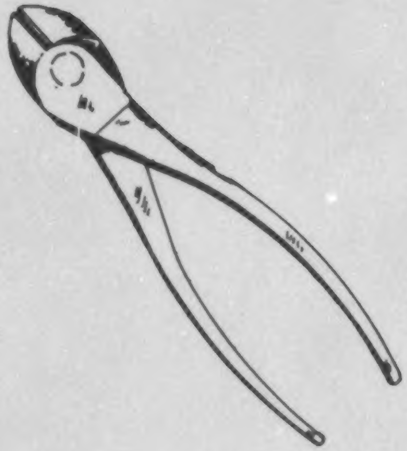
Tapered Reamer



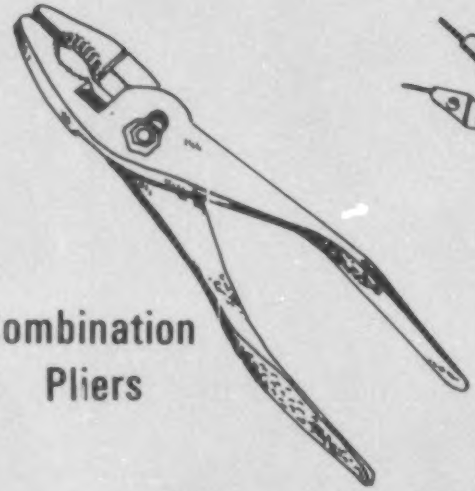
Hose Clamp Pliers



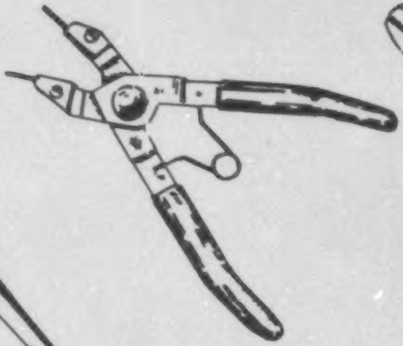
Rib Joint Pliers



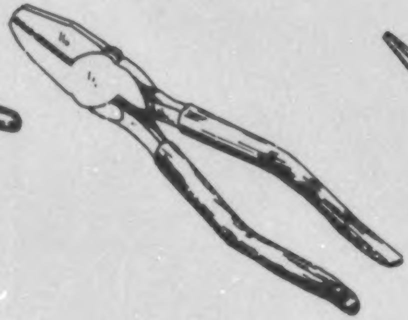
Diagonal Pliers



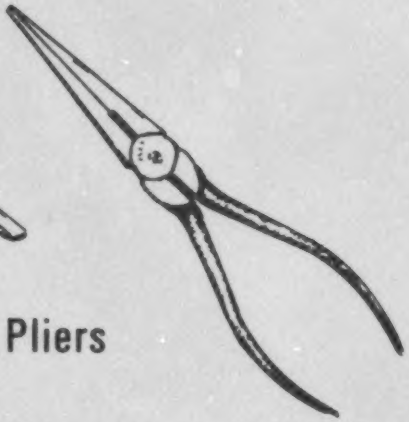
Combination Pliers



Snap Ring Pliers



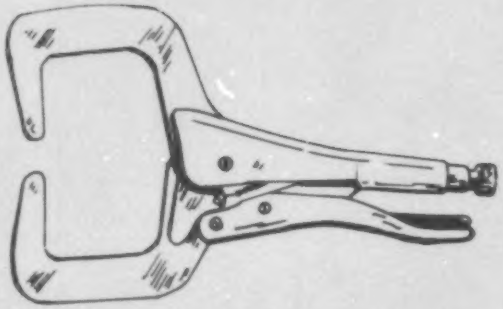
Lineman Pliers



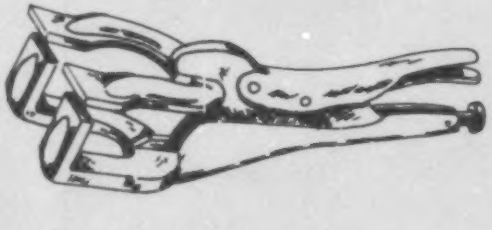
Needle Nose Pliers

Hand Tools

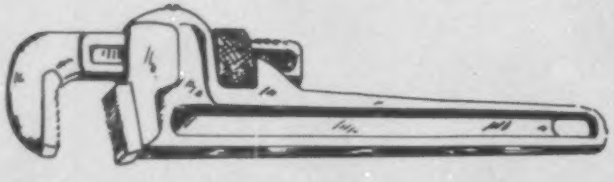
(Continued)



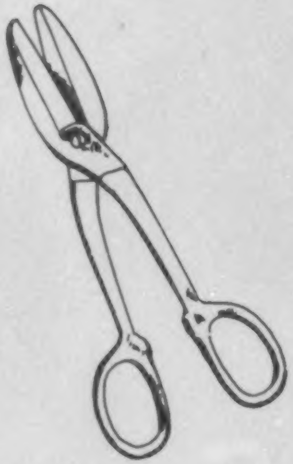
"C" Clamp Pliers



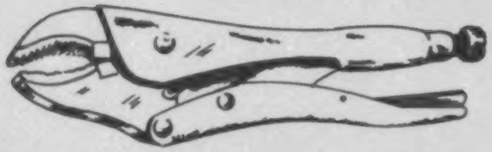
Welding Clamp Pliers



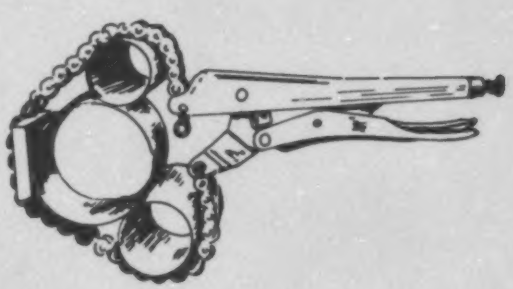
Pipe Wrench



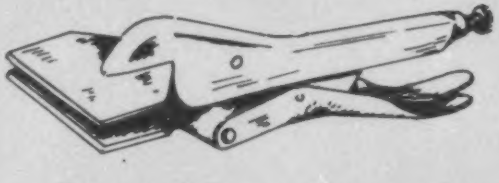
Tin Snips



Standard Grip Pliers



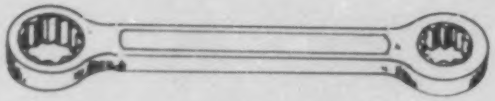
Chain Wrench Pliers



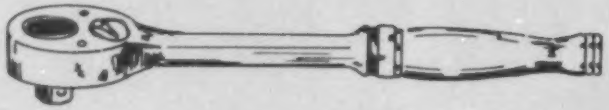
Sheet Metal Pliers

Hand Tools

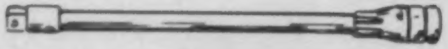
(Continued)



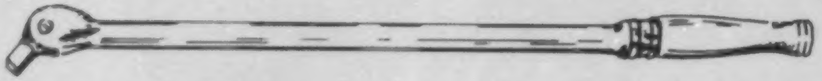
Rachet Wrench



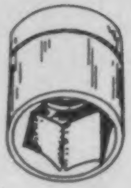
Rachet



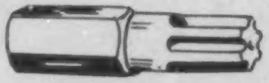
Extention



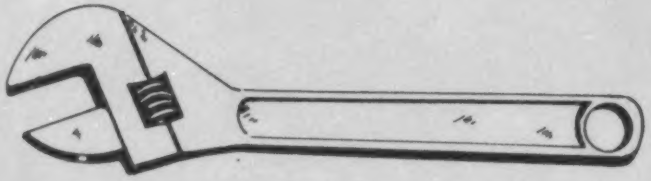
Break Over Handle



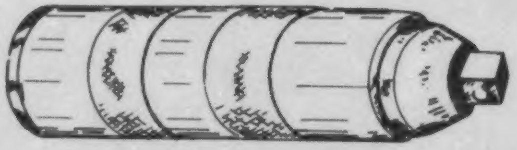
Socket



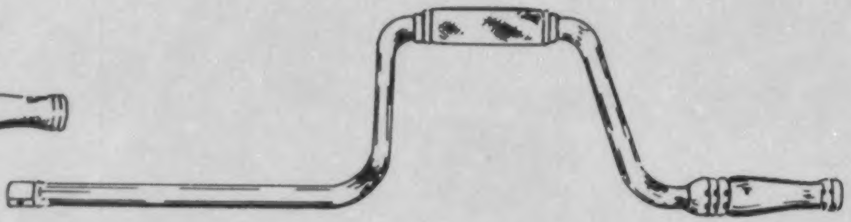
Torx Bit



Adjustable Wrench



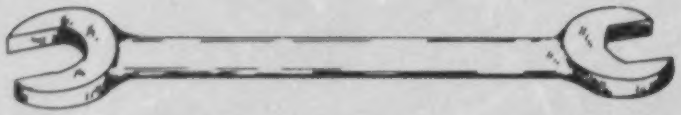
Hand Impact Driver



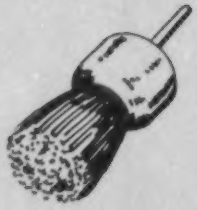
Speed Handle

Hand Tools

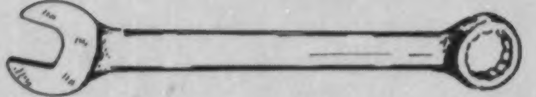
(Continued)



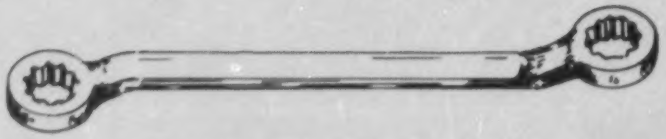
End Wrench



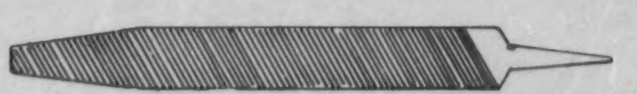
Carbon Brush



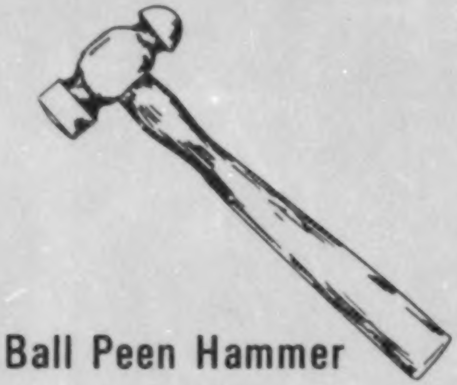
Combination End Wrench



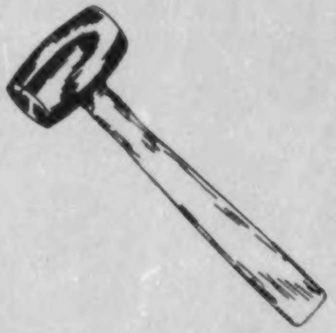
Box End Wrench



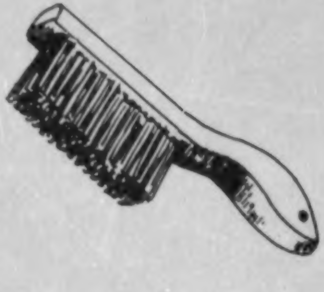
File



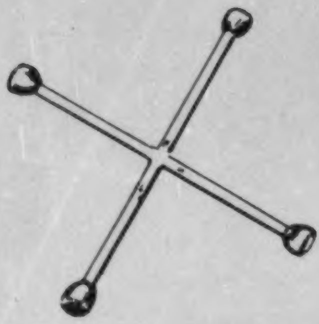
Ball Peen Hammer



Rubber Mallet



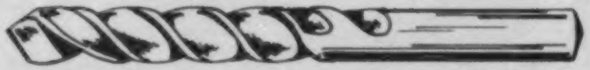
Wire Brush

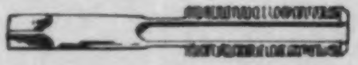


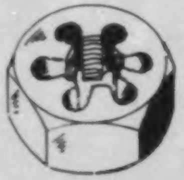
Tire Tool

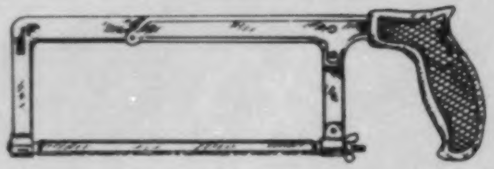
Hand Tools

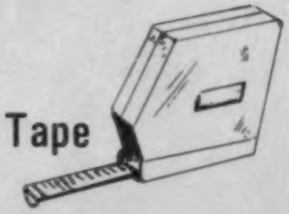
(Continued)

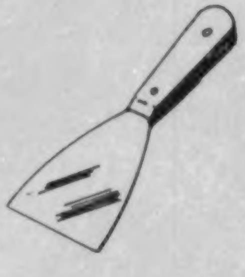

Drill Bit

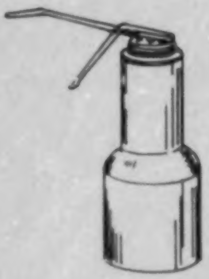

Tap

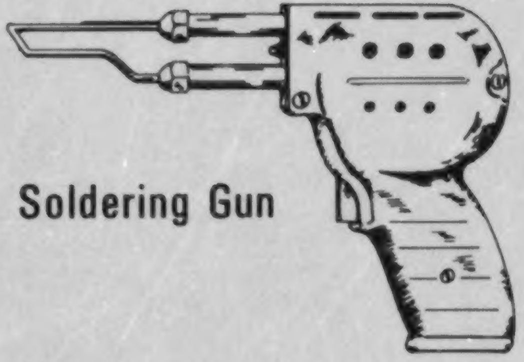

Die

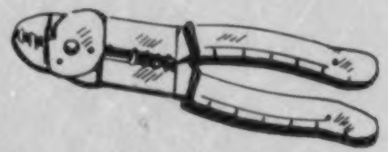

Hacksaw

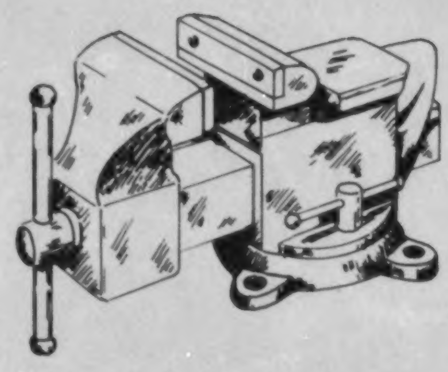

Measuring Tape


Putty Knife

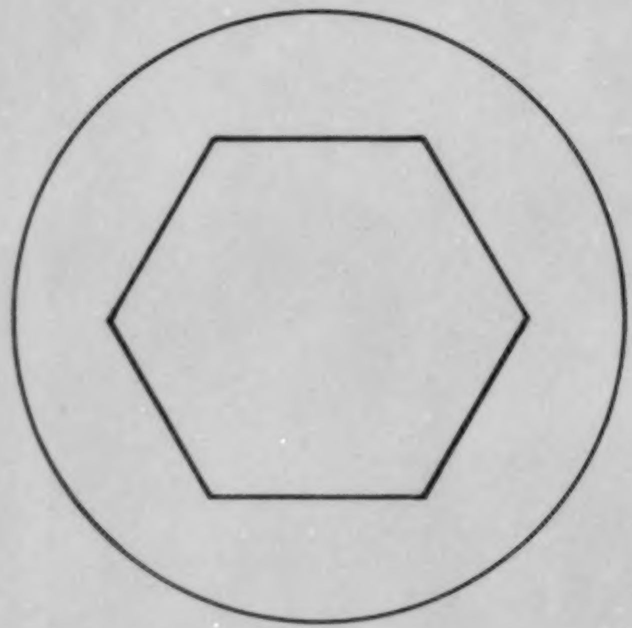

Oil Can


Soldering Gun

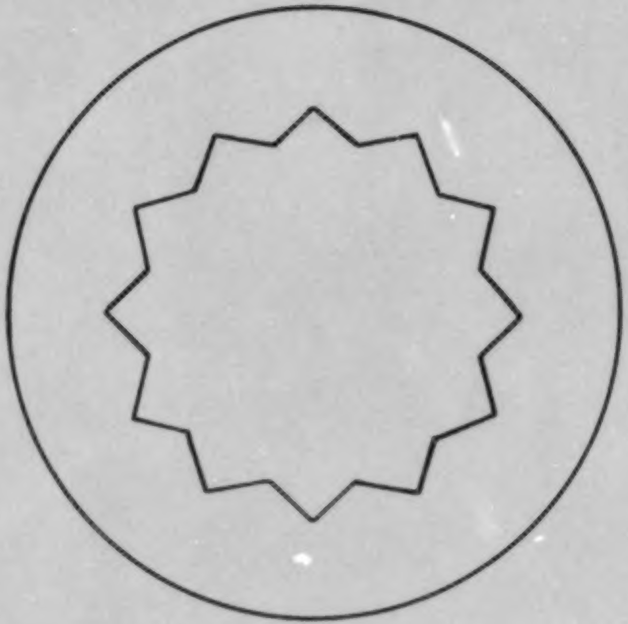

Cruncut Tool


Vise

Six Point and Twelve Point Sockets

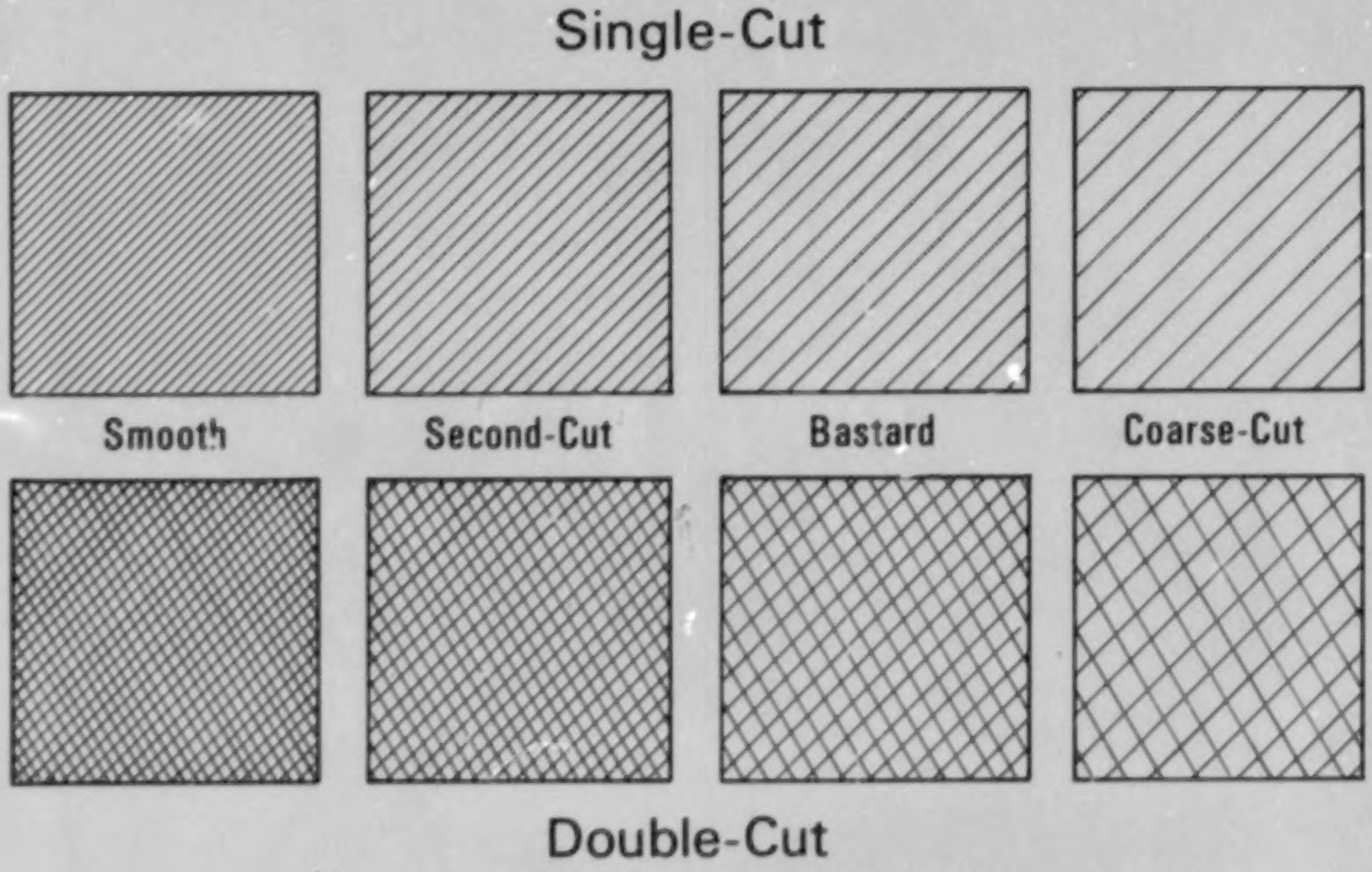


6-Point Socket

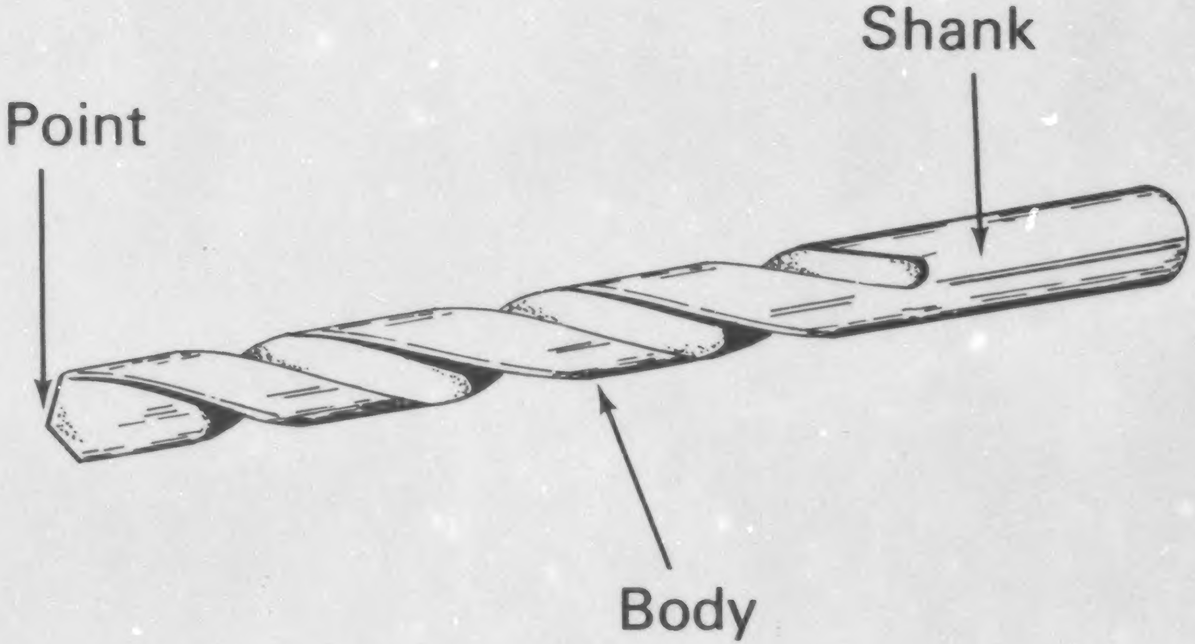


12-Point Socket

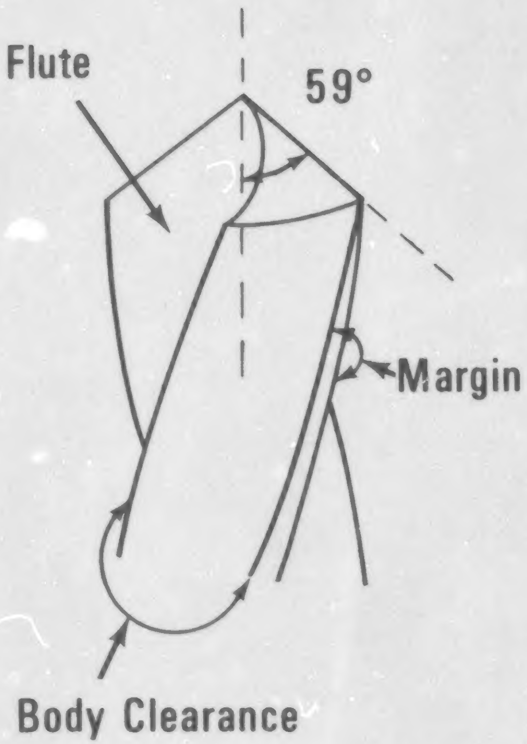
Types of Files and Cuts

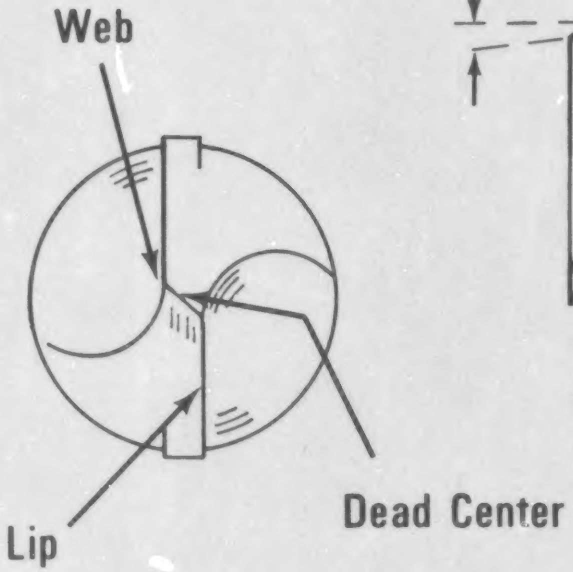

Single-Cut
Smooth
Second-Cut
Bastard
Coarse-Cut
Double-Cut

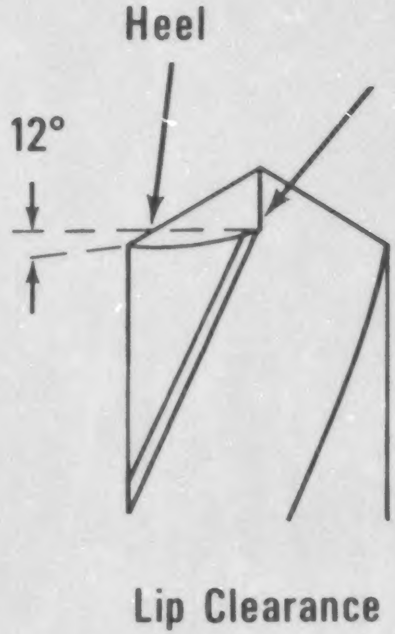
Drill Bit Sections


Shank
Point
Body

Drill Bit Parts


Flute
59°
Margin
Body Clearance


Web
Lip
Dead Center


Heel
12°
Lip Clearance

GENERAL HAND TOOLS
UNIT I

JOB SHEET #1--GRIND A STRAIGHT BLADE SCREWDRIVER

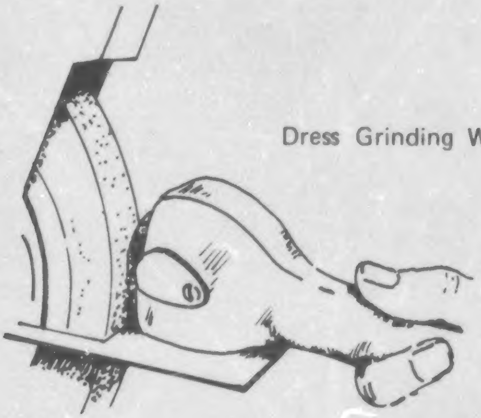
I. Tools and equipment needed

- A. Straight blade screwdriver
- B. Pedestal grinder
- C. Grinder dresser tool
- D. Water tray
- E. Goggles

II. Procedure

- A. Put on goggles
- B. Turn on grinder
- C. Dress grinding wheel if needed (Figure 1)

FIGURE 1



Dress Grinding Wheel

- D. Turn off grinder
- E. Adjust tool rest to proper clearance

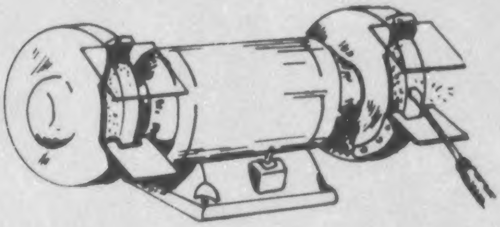
  (NOTE: Proper clearance is approximately one-eighth inch from grinding wheel.)

JOB SHEET #1

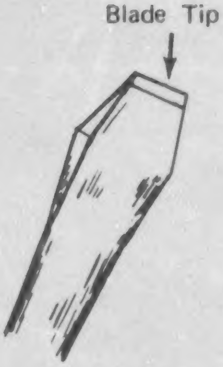
F. Turn on grinder

G. Grind top of blade flat (Figure 2)

FIGURE 2



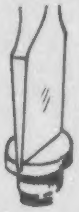
Bench Grinder



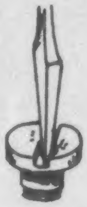
(CAUTION: Wear eye protection when using a bench grinder to prevent injury to the operator.)

H. Dress sides of blade so blade will fit screw (Figure 3)

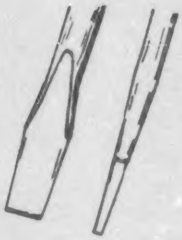
FIGURE 3



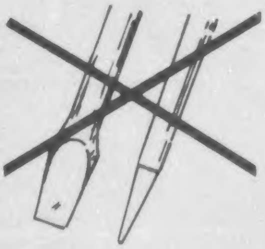
Correct Screwdriver Fit



Pour Fit Damages Screwdriver and Screw Slot



Ground Right



Ground Wrong

(NOTE: Do not get the tip of a screwdriver red hot while grinding or it will be ruined.)

GENERAL HAND TOOLS
UNIT I

JOB SHEET #2--DRESS A FLAT CHISEL AND A PUNCH

I. Tools and equipment needed

  A. Flat chisel and a punch

  B. Pedestal grinder

  C. Grinder dresser tool

  D. Water tray

  E. Goggles

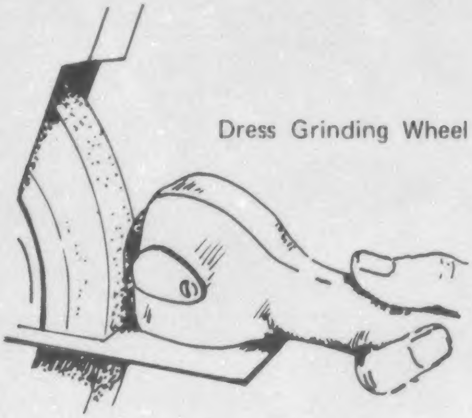
II. Procedure

  A. Put on goggles

  B. Turn on grinder

  C. Dress grinding wheel if needed (Figure 1)

FIGURE 1



  D. Turn off grinder

  E. Adjust tool rest to proper clearance

  (NOTE: Proper clearance is approximately one-eighth inch from grinding wheel.)

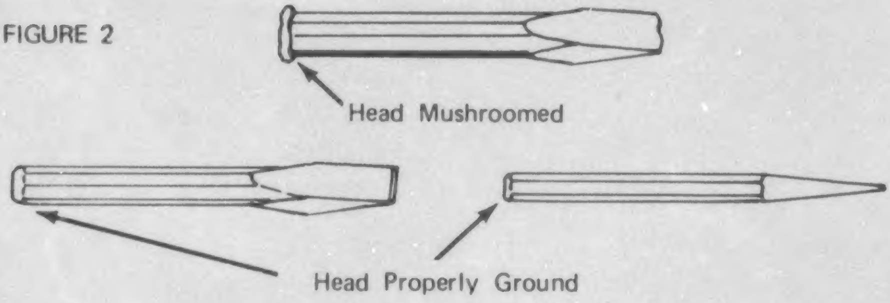
  F. Turn on grinder

JOB SHEET #2

G. Grind head of chisel or punch (Figure 2)

(CAUTION: When the head of a punch or chisel is mushroomed, chips could fly off during use causing injury to the user.)

FIGURE 2

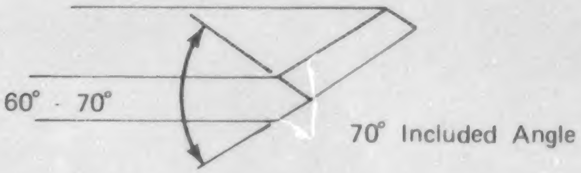

Head Mushroomed
Head Properly Ground

(CAUTION: Wear eye protection when using bench grinder to prevent injury to operator.)

H. Grind chisel or punch

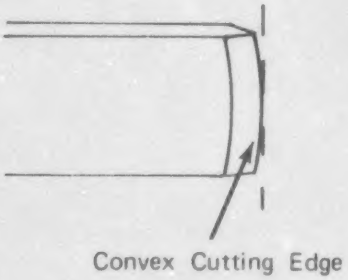
1. Grind cutting edge of chisel to have an included angle of 60° to 70° (Figure 3)

FIGURE 3


60° - 70°
70° Included Angle

2. Grind cutting edge slightly convex (Figure 4)

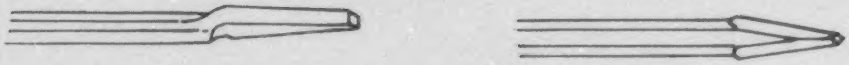
FIGURE 4


Convex Cutting Edge

JOB SHEET #2

3. Grind other chisels to desired shape (Figure 5)

FIGURE 5

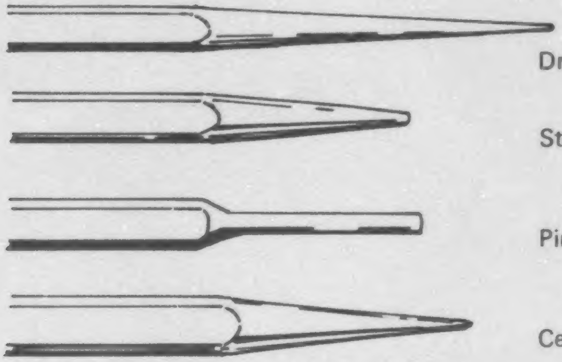


Cape Chisel

Diamond Point Chisel

4. Grind punch tips to desired shape (Figure 6)

FIGURE 6



Drift or Taper Punch

Starter Punch

Pin Punch

Center Punch

(NOTE: Do not get the tip of a punch or chisel red hot while grinding or it will be ruined.)

GENERAL HAND TOOLS
UNIT I

JOB SHEET #3--SHARPEN A TWIST DRILL BIT

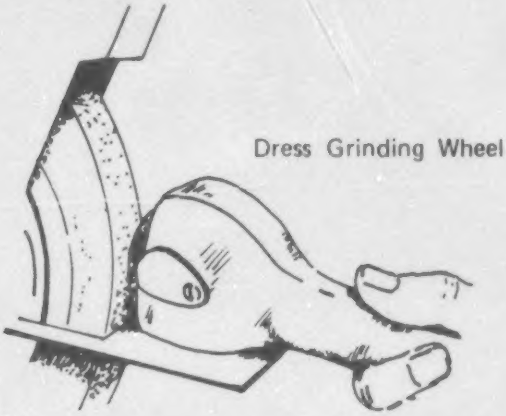
I. Tools and equipment needed

- A. Drill bit
- B. Pedestal grinder
- C. Grinder dresser tool
- D. Water tray
- E. Goggles
- F. Drill bit gauge
- G. Oil stone

II. Procedure

- A. Put on goggles
- B. Turn on grinder
- C. Dress grinding wheel if needed (Figure 1)

FIGURE 1



Dress Grinding Wheel

- D. Turn off grinder
- E. Adjust tool rest to proper clearance

  (NOTE: Proper clearance is approximately one-eighth inch from wheel.)

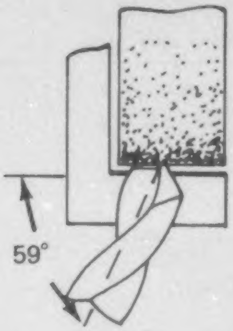
JOB SHEET #3

F. Turn on grinder

G. Grind each lip of the drill bit to proper angle of 59° (Figure 2)

(CAUTION: Wear eye protection when using a bench grinder to prevent injury to the operator.)

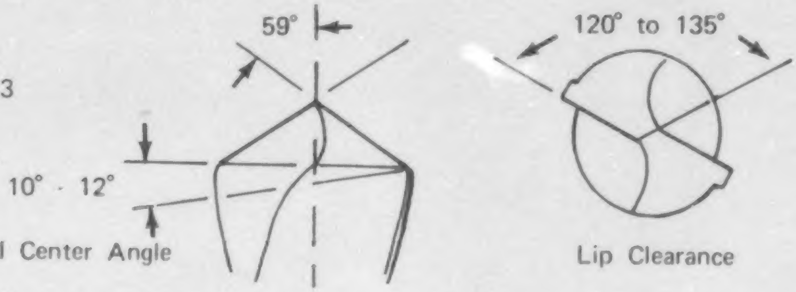
FIGURE 2



Grinding the Drill

H. Roll drill bit to the right and up to the face of the stone to generate back clearance angle of 10° to 12° (Figure 3)

FIGURE 3



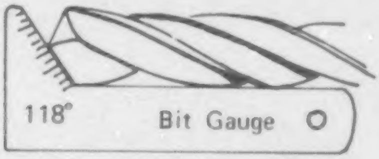
Dead Center Angle

Lip Clearance

I. Dip in water tray occasionally to prevent overheating the drill bit

J. Check correct angle with a bit gauge (Figure 4)

FIGURE 4



Check Angle

K. Turn off grinder

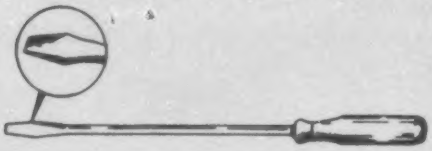
L. Hone cutting edges of the drill bit to remove burrs

M. Recheck all cutting angles

GENERAL HAND TOOLS
UNIT I

TEST

1. Identify general hand tools.



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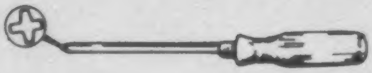

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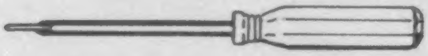

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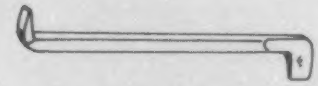

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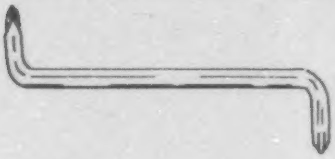

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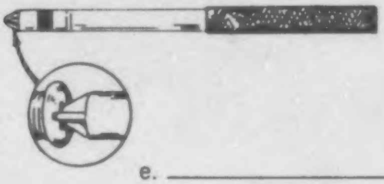

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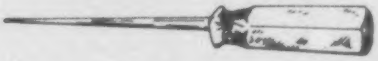

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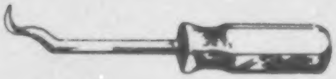

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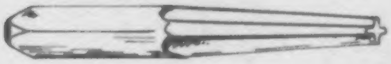

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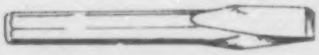

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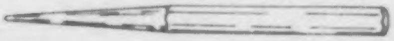

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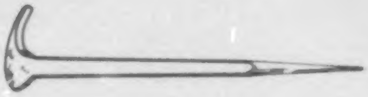

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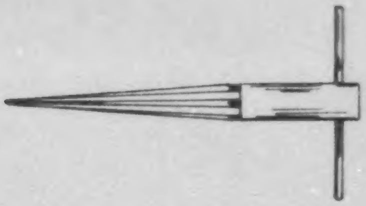

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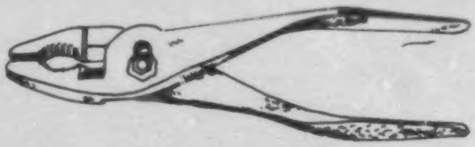

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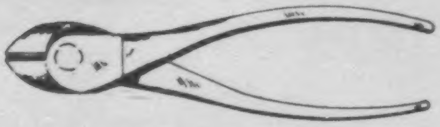

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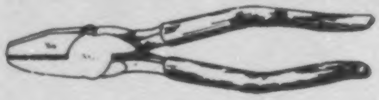

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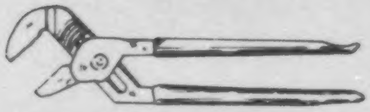

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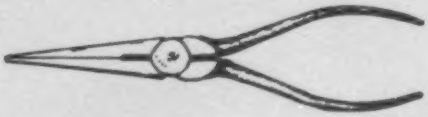

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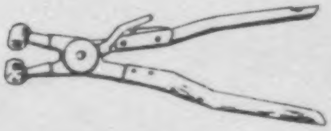

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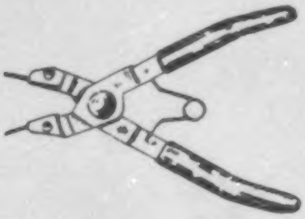

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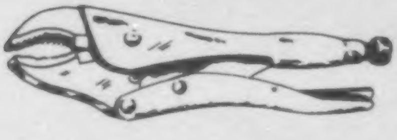

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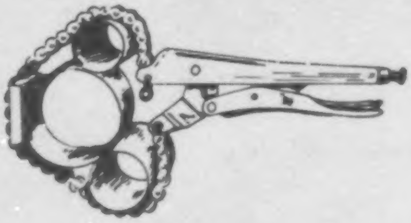

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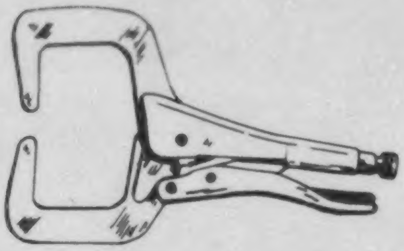

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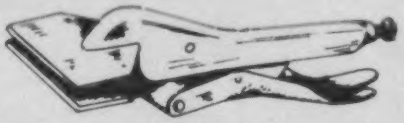

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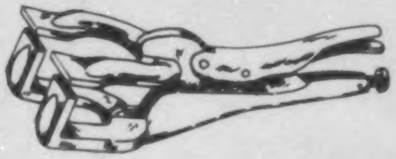

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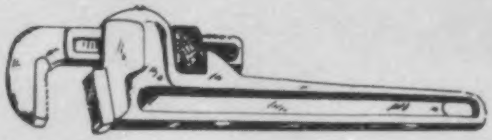

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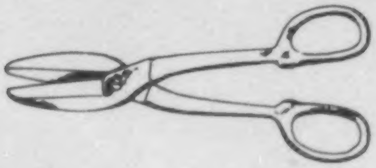

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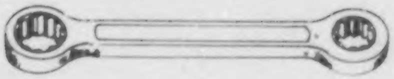

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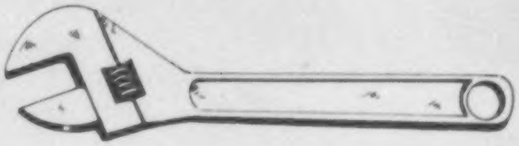

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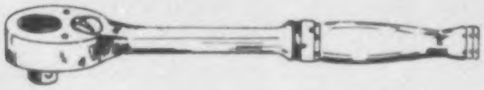

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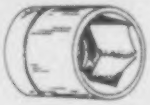

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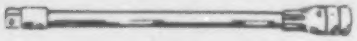

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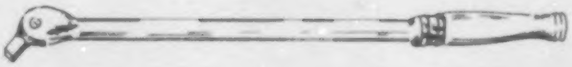

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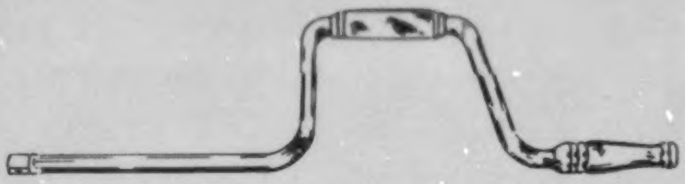

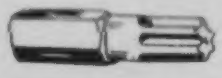

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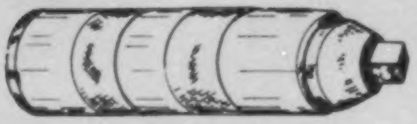

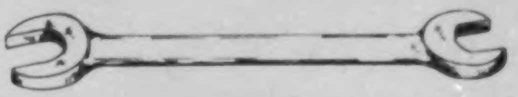

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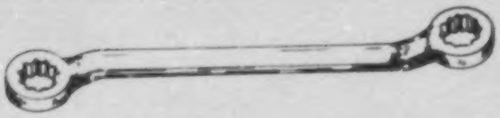

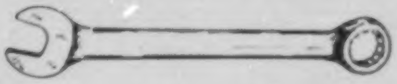

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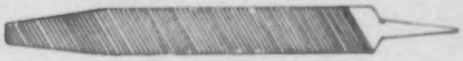

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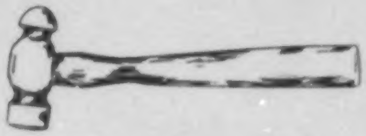

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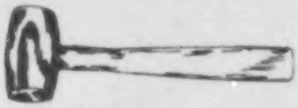

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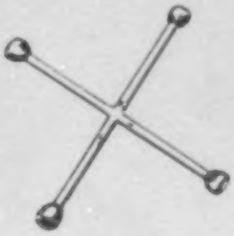

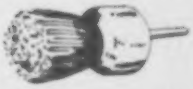

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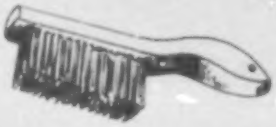

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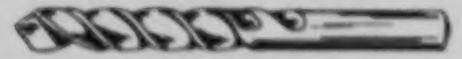

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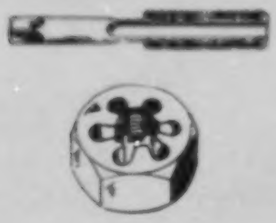

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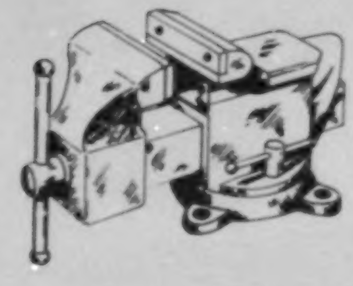

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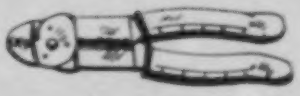

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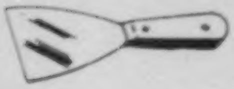

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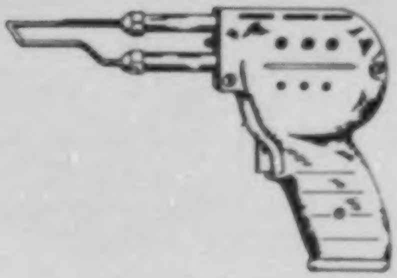

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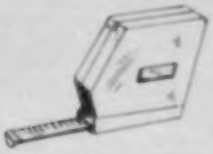

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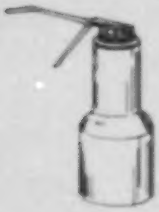

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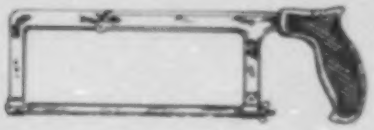
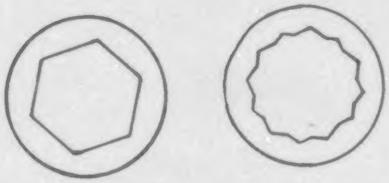


zz. ______________________

2. Describe the method for determining the size of a straight blade screwdriver.

3. Identify a six point and twelve point socket.



a. ______________ b. ______________

4. Name two ways of measuring nuts and bolts in the automotive industry.

[illegible].

b.

5. List four socket drives that are common to the automotive industry.

a.

b.

c.

d.

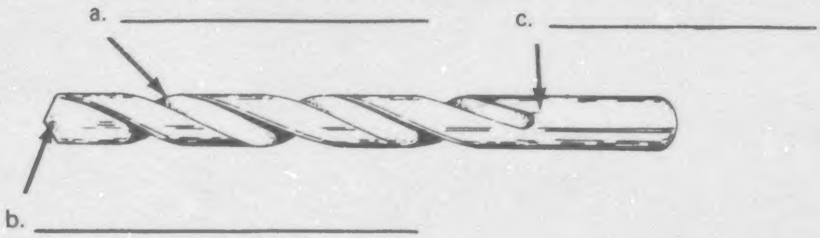
6. Tell how many teeth of a hacksaw blade should be in contact with the surface at all times.

7. Name four grades of coarseness files can have.
   a.
   b.
   c.
   d.

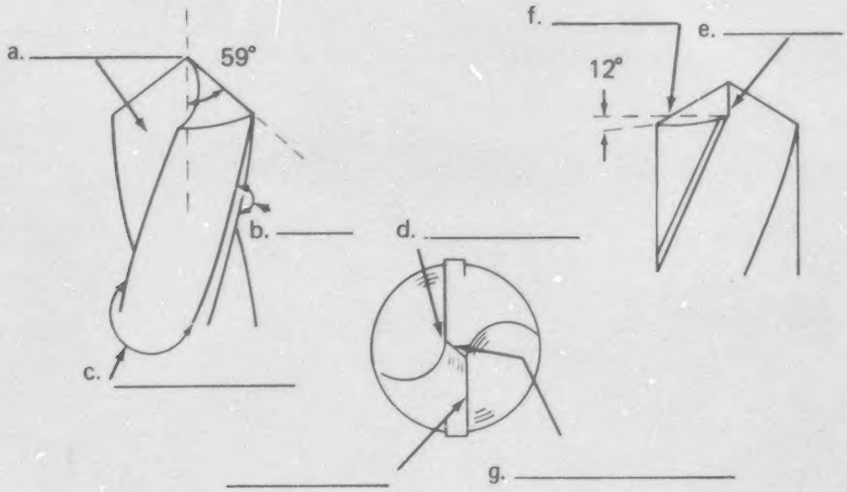
8. Name two types of cuts that all four grades can have.
   a.
   b.

9. Name three uses of a cold chisel.
   a.
   b.
   c.

10. Identify three main sections of a drill bit.



11. Identify the parts that make up the body of the drill bit.



12. Tell how the size of a hammer is determined.

13. Demonstrate the ability to:

a. Grind a straight screwdriver.

b. Dress a flat chisel and a punch.

c. Sharpen a drill bit.

d. Use all hand tools safely and correctly.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

GENERAL HAND TOOLS
UNIT I

ANSWERS TO TEST

1. a. Standard screwdriver
   b. Phillips screwdriver
   c. Clutch head screwdrivers
   d. Offset screwdriver
   e. Screw starter
   f. Scratch awl
   g. Cotter pin puller
   h. Screw extractor
   i. Chisel
   j. Punch
   k. Pry bar
   l. Tapered reamer
   m. Combination pliers
   n. Diagonal pliers
   o. Lineman pliers
   p. Rib joint pliers
   q. Needle nose pliers
   r. Hose clamp pliers
   s. Snap ring pliers
   t. Standard grip pliers
   u. Chain wrench pliers
   v. "C" clamp pliers
   w. Sheet metal pliers

x. Welding clamp pliers
y. Pipe wrench
z. Tin snips
aa. Ratchet wrench
bb. Adjustable wrench
cc. Ratchet
dd. Socket
ee. Extention
ff. Break over handle
gg. Speed handle
hh. Hand impact driver and torx bit
ii. End wrench
jj. Box end wrench
kk. Combination end wrench
ll. File
mm. Ball peen hammer
nn. Rubber mallet
oo. Tire tool
pp. Carbon brush
qq. Wire brush
rr. Drill bit
ss. Tap and die
tt. Vise
uu. Cruncut tool
vv. Putty knife
ww. Soldering gun

xx. Measuring tape

yy. Oil can

zz. Hacksaw

2. Screwdriver sizes are determined by the combined length of the shank and blade; blade width and thickness are proportioned to the diameter and length of the shank

3. a. Six point socket

   b. Twelve point socket

4. a. The North American automobile industry uses the inch and millimeter to measure nuts and bolts

   b. European industry uses the metric

5. a. 1/4 drive or midget drive

   b. 3/8 drive

   c. 1/2 drive

   d. 3/4 drive

6. At least two teeth should be in contact with the surface

7. a. Smooth

   b. Second-cut

   c. Bastard

   d. Coarse-cut

8. a. Single-cut

   b. Double-cut

9. a. To cut metal

   b. To break spot welds

   c. To split nuts

10. a. Body

   b. Point

   c. Shank

11. a. Flute
    b. Margin
    c. Body clearance
    d. Web
    e. Lip
    f. Heel
    g. Center

12. Determined by the weight of the hammerhead

13. Performance skills will be evaluated according to the criteria listed on the progress chart.

BODY HAND TOOLS
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to identify and choose the proper body tool for the proper job. He should be able to use all body tools and clean and polish finishing hammers, dolly blocks, and spoons. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify body straightening tools.
2. Identify two body filling tools.
3. Identify twelve body specialty tools.
4. Identify five types of eye protection equipment.
5. Name two uses of a bumping hammer.
6. Describe the finger movement when using the body hammer.
7. Describe the finger-wrist movement when using the body hammer.
8. List three uses of dolly blocks.
9. List three uses of body spoons.
10. Describe how the faces of dollies, hammers, and spoons should be conditioned.
11. Describe how the teeth of a body file differ from those of a standard file.
12. Demonstrate the ability to:
    a. Recondition a finishing hammer.
    b. Recondition a dolly block.
    c. Recondition a body spoon.
    d. Use all body tools safely and correctly.

BODY HAND TOOLS
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1-Body Straightening Tools

      2. TM 2-Body Straightening Tools (Continued)

      3. TM 3-Body Straightening Tools (Continued)

4. TM 4--Body Straightening Tools (Continued)
5. TM 5--Body Straightening Tools (Continued)
6. TM 6--Body Filling Tools
7. TM 7--Body Speciality Tools
8. TM 8--Body Speciality Tools (Continued)
9. TM 9--Eye Protection Equipment

D. Job sheets

1. Job Sheet #1--Recondition a Finishing Hammer
2. Job Sheet #2--Recondition a Dolly Block
3. Job Sheet #3--Recondition a Body Spoon

E. Test

F. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd. 1969.

B. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

C. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

D. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

BODY HAND TOOLS
UNIT II

INFORMATION SHEET

I. Body straightening tools (Transparencies 1, 2, 3, 4, and 5)

   A. Pick hammer

   B. Dinging hammer

   C. Bumping hammer

   D. Cross peen hammer

   E. Shrinking hammer

   F. Magnetic trim hammer

   G. Egg dolly block

   H. Bumping dolly

   I. General purpose or railroad dolly

   J. Loaf dolly block

   K. Toe dolly block

   L. Heel dolly block

   M. Shrinking dolly

   N. Comma or wedge dolly block

   O. Backup and driving spoon

   P. Spring hammering spoon

   Q. Body file blade

   R. Straight file holder

   S. Curved file holder

   T. Flexible file holder

   U. Reveal file holder and blades

   V. Bumping or slapping file

   W. Spoon dolly

   X. Slide hammer

INFORMATION SHEET

Y. Caulking iron

Z. Curved short pick

AA. Curved long pick

BB. Deep throat curved pick

CC. Top rail pick tool

DD. Straight finishing pick

EE. Curved finishing pick

FF. Hooked finishing pick

GG. Body plastic shaping file

HH. Body plastic finishing board file

II. Body filling and shaping tools (Transparency 6)

A. Lead paddles

B. Putty knife or plastic squeeze

III. Body specialty tools (Transparencies 7 and 8)

A. Drip molding pliers

B. Door and window handle clip remover

C. Reveal molding clip tool

D. Windshield knife

E. Vacuum lifter

F. Molding clip pliers

G. Pop rivet gun

H. Locking strip tool

I. Door hinge wrench

J. Bumper bracket tool

K. Door hinge aligner

L. Body pull rod set

INFORMATION SHEET

IV. Eye protection equipment (Transparency 9)

  A. Goggles

  B. Safety shield

  C. Safety glasses

  D. Welding goggles

  E. Arc welding helmet

V. Use of a bumping hammer

  A. Roughing out damaged areas

  B. Straightening heavier panels, bumpers, frame rails, and other areas

VI. Finger movement when using the body hammer

  A. Hold the hammer loosely

  B. Close hand to strike blow

  (NOTE: The hammer will strike the surface with sufficient force to straighten metal and will not stretch it.)

VII. Finger-wrist movement when using the body hammer

(NOTE: Wrist movement comes at the end of finger movement before the hammer head strikes the metal to add accuracy and strength to the blow.)

  A. Increase your arm angle with the surface so finger movement will end at a twenty or twenty-five degree angle

  B. Add wrist movement to complete the hammer blow to the surface

VIII. Uses of dolly blocks

  A. To back up or support damaged metal when it is being hammered back into shape

  B. As a striking tool to drive metal into shape

  C. As forming tools to form metal in construction of replacement panels or sections

INFORMATION SHEET

IX. Uses of body spoons

  A. In place of dollies

  B. As pry tools to lift low spots

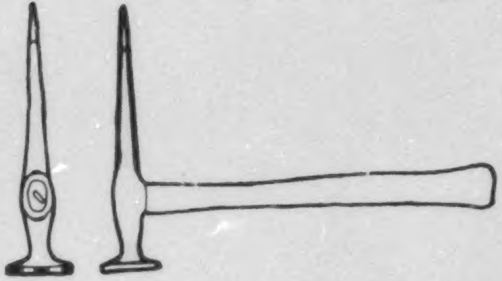
  C. To spring hammer ridges and creases

X. Conditioning the faces of dollies, hammers, and spoons--The faces should be kept smooth using sandpaper, emery cloth, and in extreme damage cases, the use of a fine file to remove pits and scratches

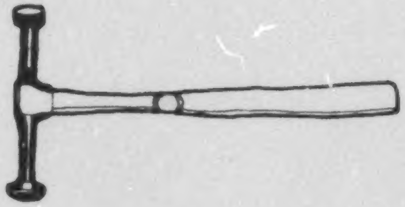
XI. Difference between the teeth of a body file and the teeth of a standard file--Deep U-shaped grooves between the teeth allow shavings to escape from the body file and prevent plugging

(NOTE: See Transparency 6.)

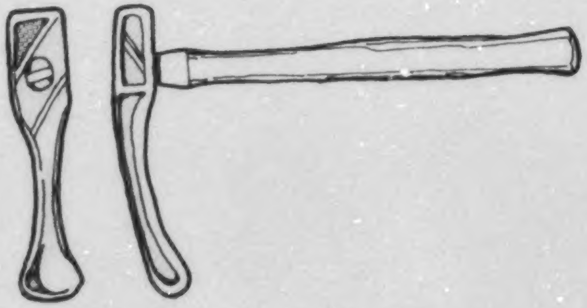
Body Straightening Tools



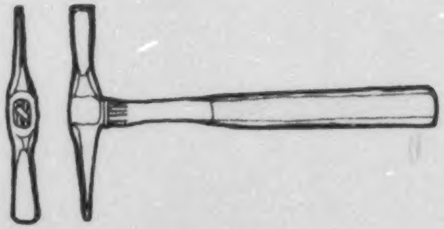
Pick Hammer



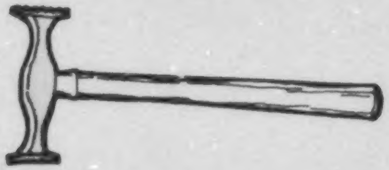
Dinging Hammer



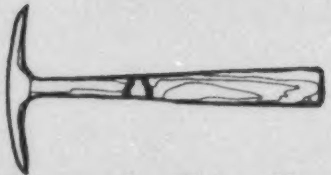
Bumping Hammer



Cross Peen Hammer



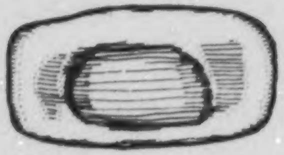
Shrinking Hammer



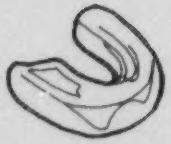
Magnetic Trim Hammer

Body Straightening Tools

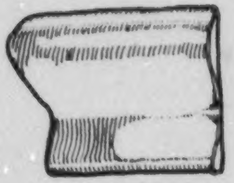
(Continued)



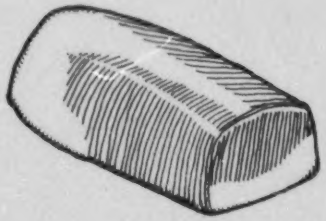
Egg Dolly



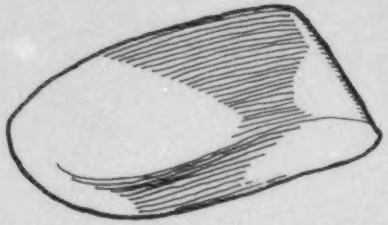
Bumping Dolly



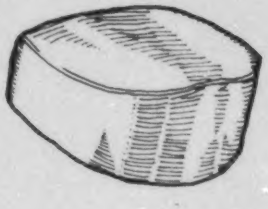
General Purpose or "Railroad Dolly"



Loaf Dolly



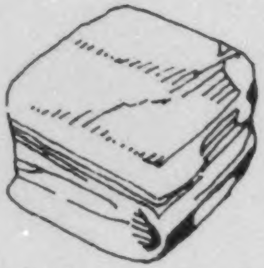
Toe Dolly

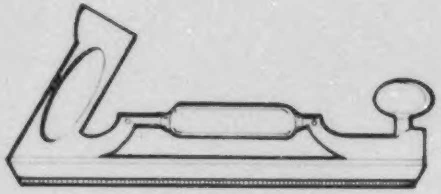


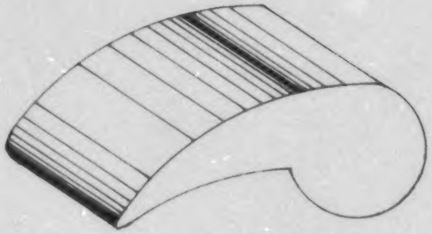
Heel Dolly

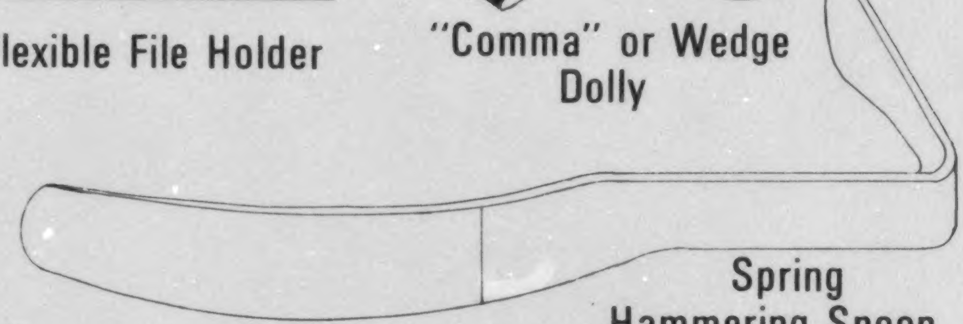
Body Straightening Tools

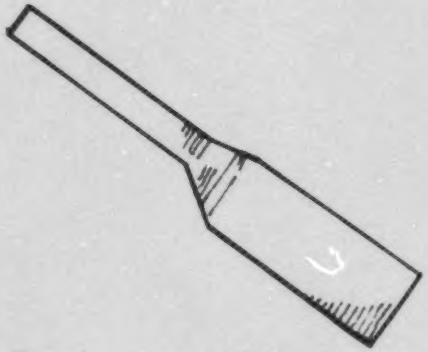
(Continued)

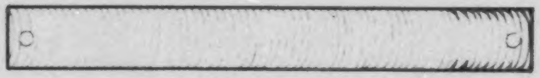

Shrinking Dolly

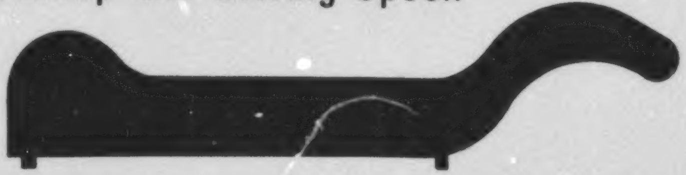

Flexible File Holder

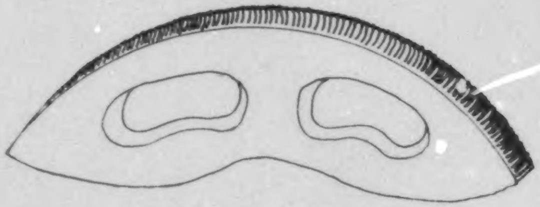

"Comma" or Wedge Dolly


Spring Hammering Spoon


Backup and Driving Spoon


Body File Blade


Straight File Holder


Curved File Holder

Body Straightening Tools

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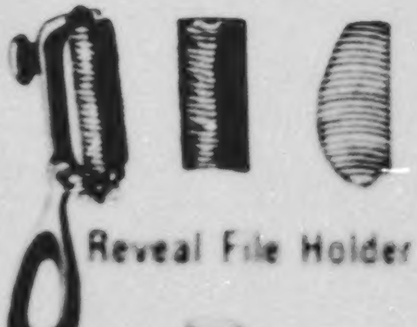
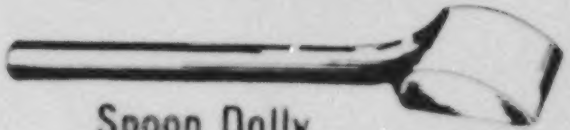
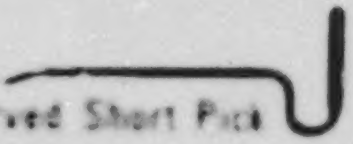


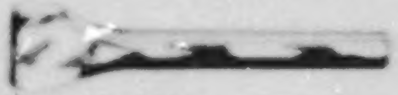
Reveal File Holder and Blades



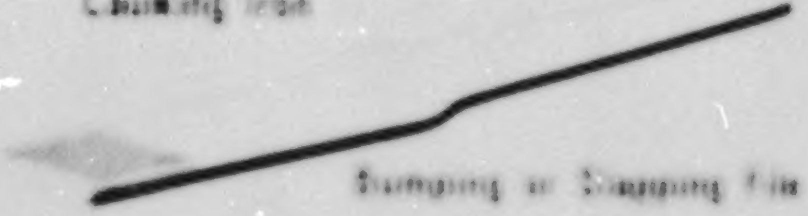
Spoon Dolly



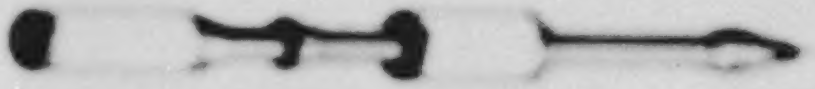
Curved Short Pick



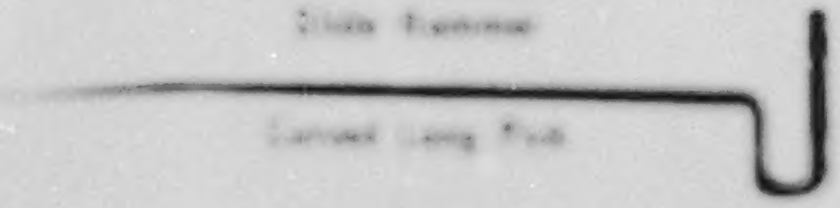
Caulking Iron



Bumping or Slapping File



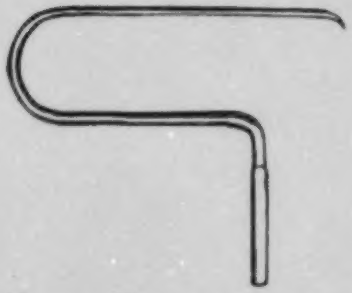
Slide Hammer



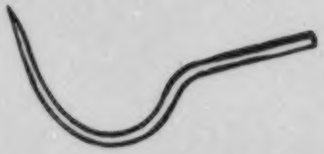
Curved Long Pick

Body Straightening Tools

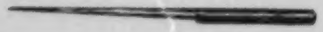
(Continued)



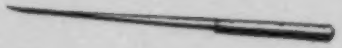
Deep Throat Curved Pick



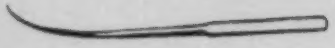
Top Rail Pick Tool



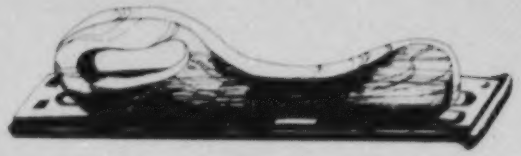
Straight Finishing Pick



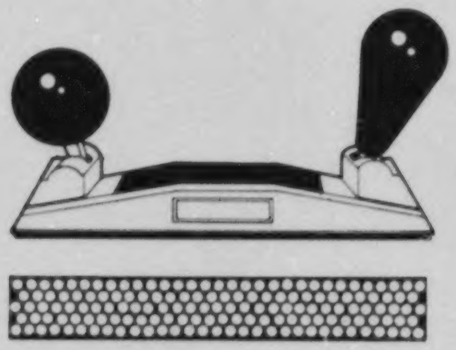
Curved Finishing Pick



Hooked Finishing Pick

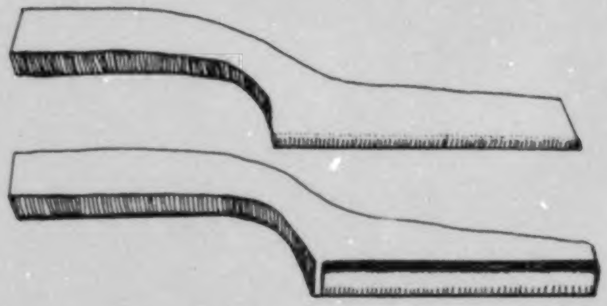


Body Plastic Finishing Board File

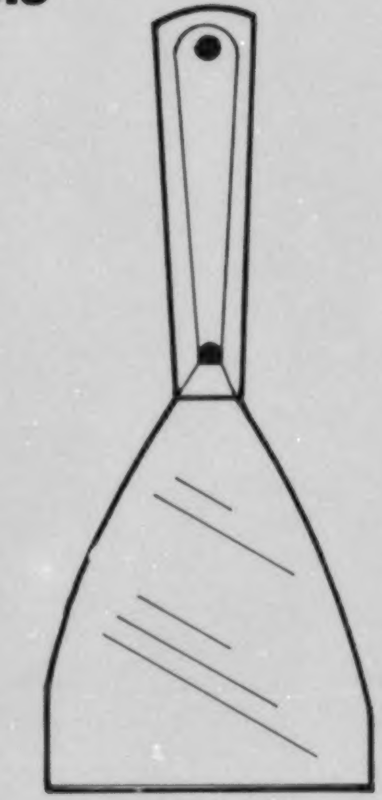


Body Plastic Shaping File

Body Filling Tools

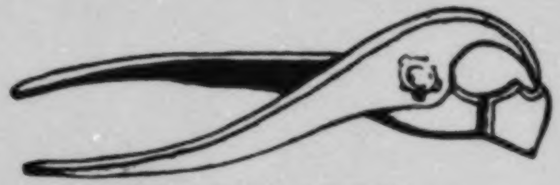


Lead Paddles

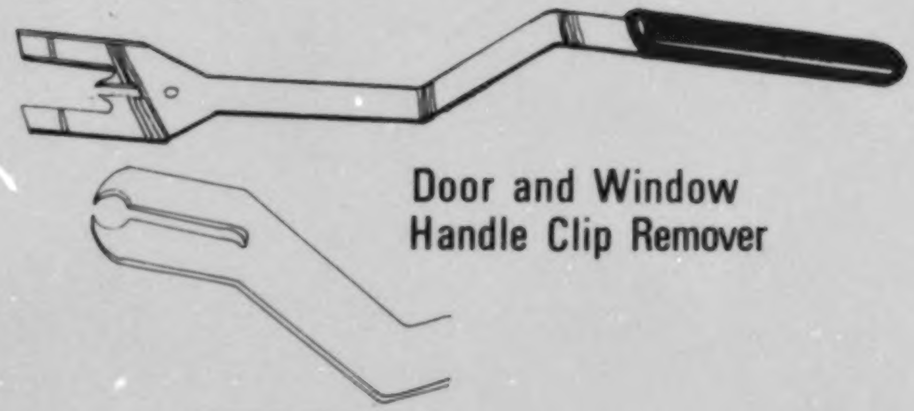


Putty Knife

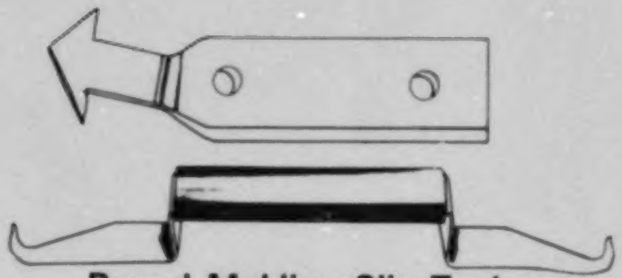
Body Specialty Tools



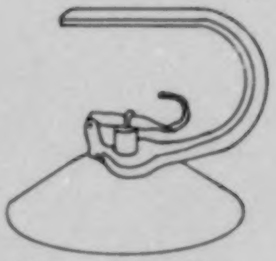
Drip Molding Pliers



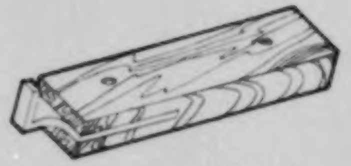
Door and Window
Handle Clip Remover



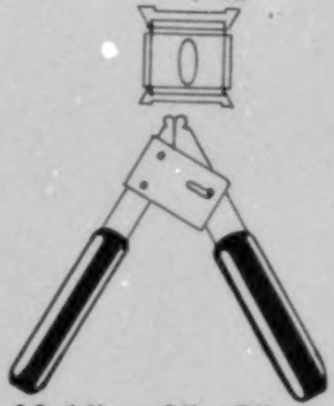
Reveal Molding Clip Tool



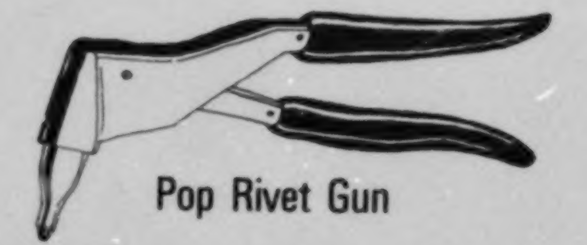
Vacuum Lifter



Windshield Knife



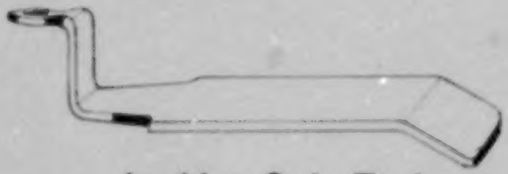
Molding Clip Pliers



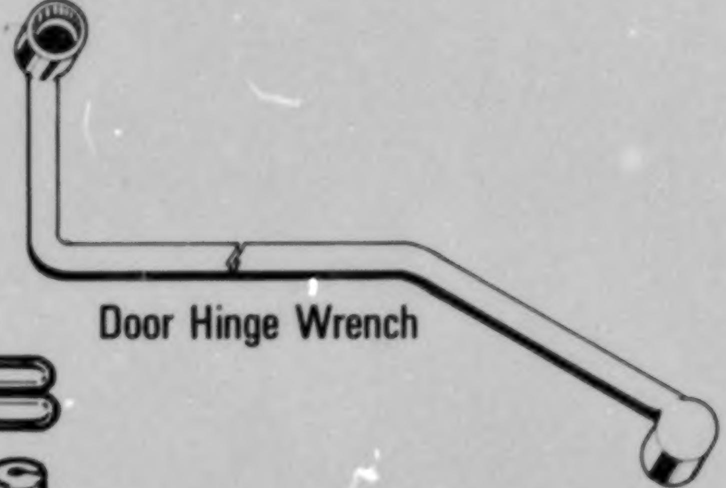
Pop Rivet Gun

Body Specialty Tools

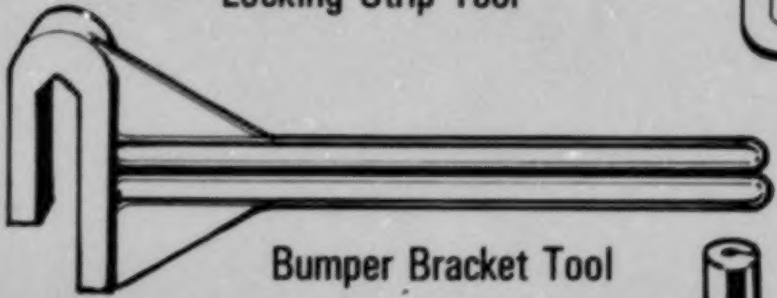
(Continued)



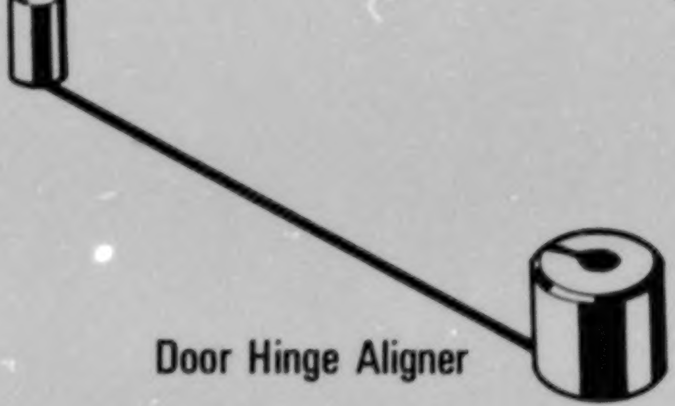
Locking Strip Tool



Door Hinge Wrench



Bumper Bracket Tool



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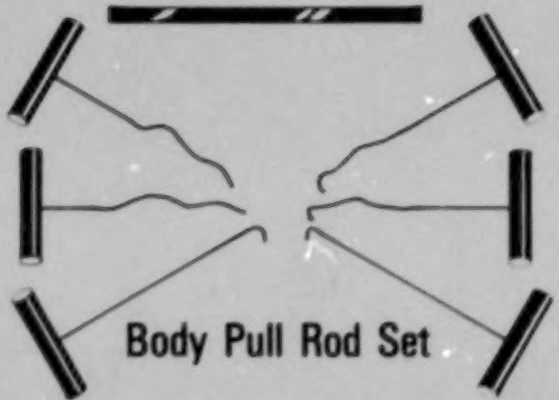
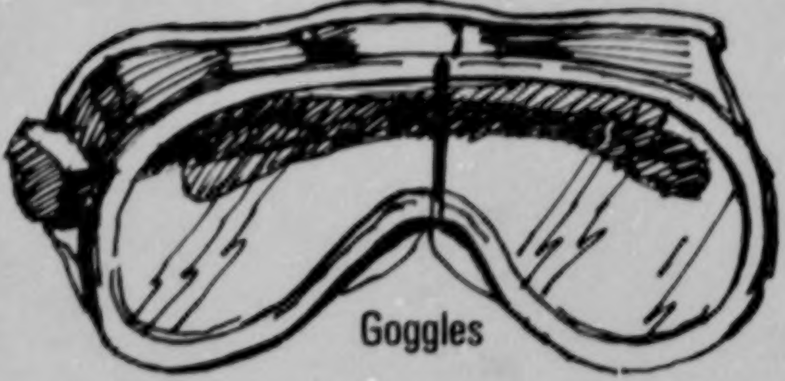
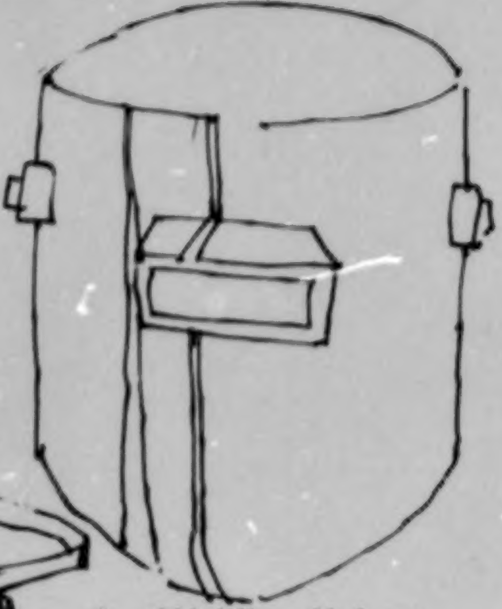


Body Pull Rod Set

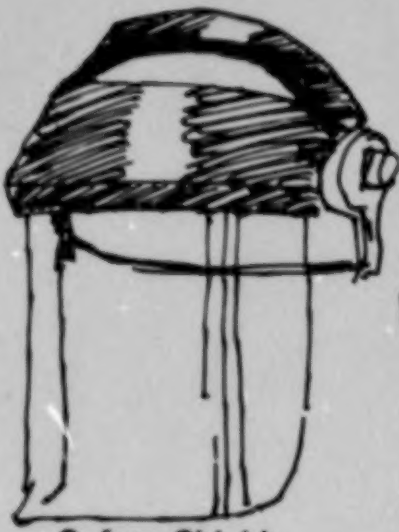
Eye Protection Equipment



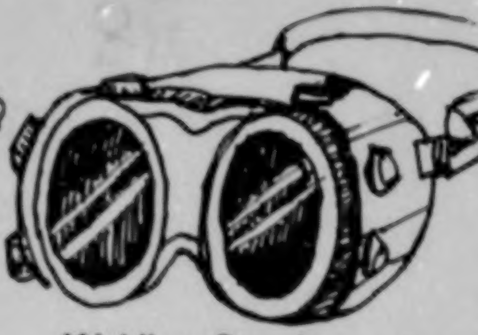
Goggles



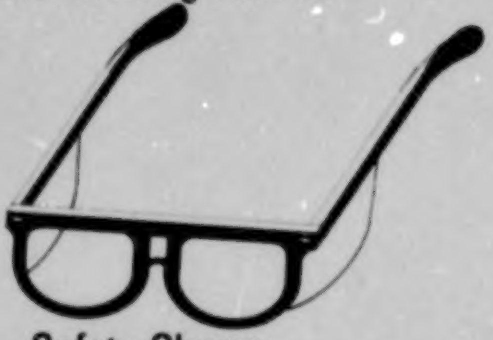
Arc Welding Helmet



Safety Shield



Welding Goggles



Safety Glasses

BODY HAND TOOLS
UNIT II

JOB SHEET #1--RECONDITION A FINISHING HAMMER

I. Tools and materials needed

   A. Finish hammer

   B. File

   C. Sandpaper or emery cloth

II. Procedure

   A. Examine the face of the hammer

      1. Check contour

      2. Check for pits in the metal

   B. File face of hammer if pitted

      1. Follow contour

      2. Remove only enough metal to remove pits

   C. Sand face

      1. Remove all file marks

      2. Smooth edges

      (NOTE: Finish hammer metal is relatively soft; therefore, do not file or sand away much metal or weight and balance will be affected.)

BODY HAND TOOLS
UNIT II

JOB SHEET #2-RECONDITION A DOLLY BLOCK

I. Tools and materials needed

  A. Dolly block

  B. File

  C. Sandpaper or emery cloth

II. Procedure

  A. Examine the faces of the dolly

    1. Check contour

    2. Check for pits

    3. Check edges for nicks

  B. File the anvil faces of dolly block if pitted

    1. Follow contour

    2. Remove only enough metal to remove pits

  C. File edges to correct nicks

  D. Sand dolly block

    1. Remove all file marks from faces

    2. Smooth edges

BODY HAND TOOLS
UNIT II

JOB SHEET #3--RECONDITION A BODY SPOON

I. Tools and materials needed

  A. Body spoon

  B. File

  C. Sandpaper or emery cloth

II. Procedure

  A. Examine the body spoon

    1. Check faces

    2. Check edges

  B. File body spoon

    1. Align contour of edges

    2. Correct finished face distortion due to heavy hammering

  C. Sand body spoon

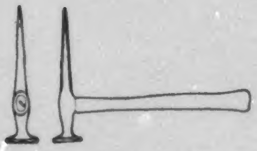
    1. Smooth finished face

    2. Smooth edges

BODY HAND TOOLS
UNIT II

TEST

1. Identify body straightening tools.



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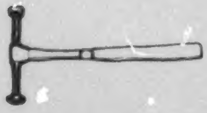

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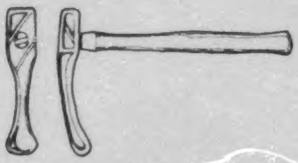

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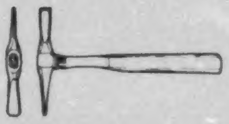

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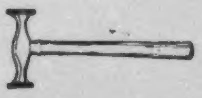

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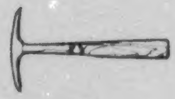

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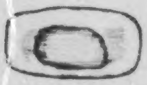

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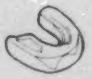

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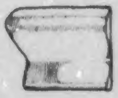

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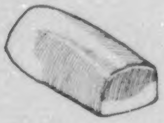

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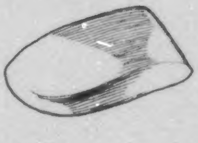

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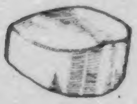

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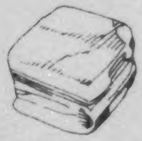

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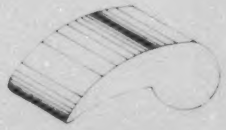

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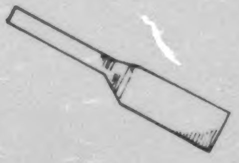

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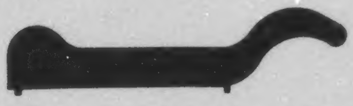

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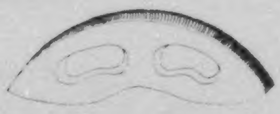

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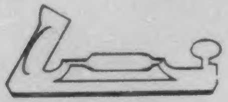

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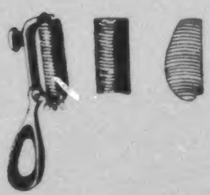

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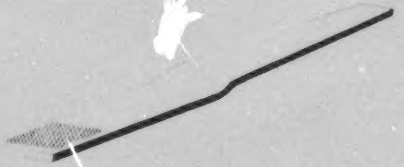

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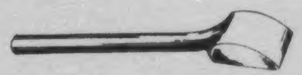

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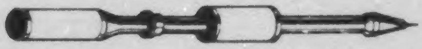

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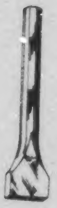

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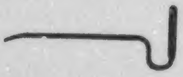

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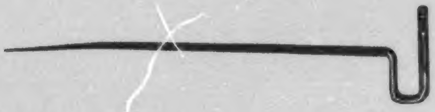

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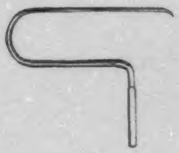

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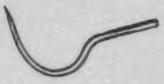

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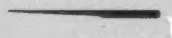

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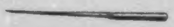

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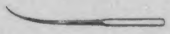

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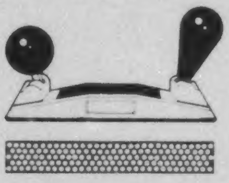

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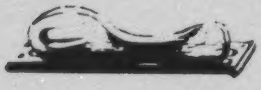
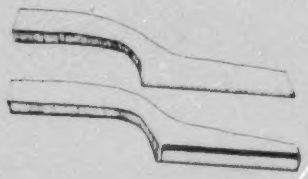


hh. _________________

2. Identify two body filling tools.



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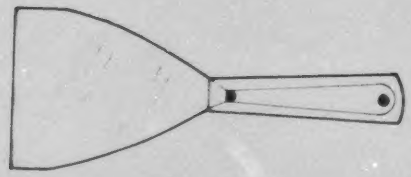
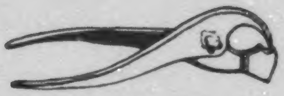
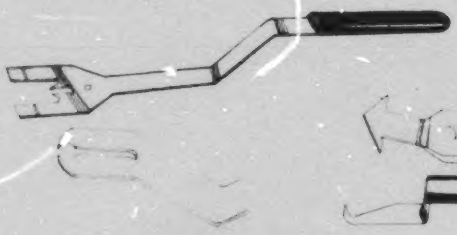
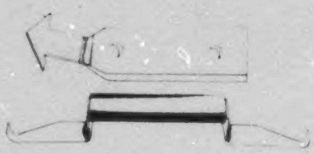


b. ____________________

3. Identify twelve body specialty tools.







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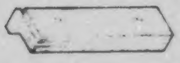
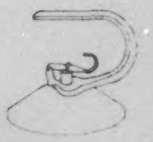
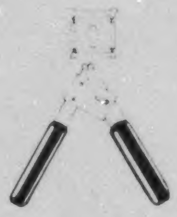
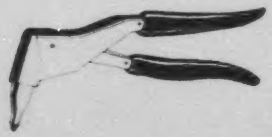
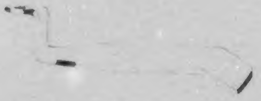


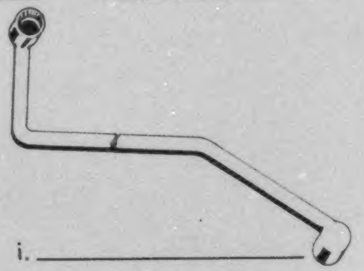




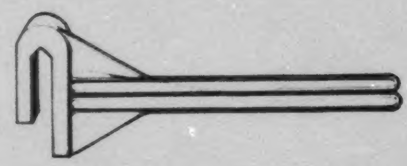
d. ____________________ e. ____________________ f. ____________________







g. ____________________ h. ____________________ i. ____________________



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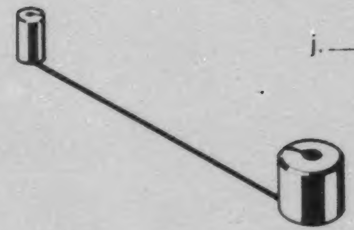
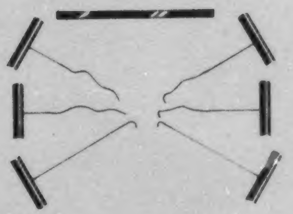
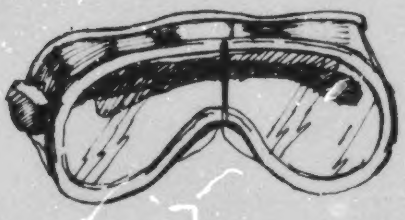




k. ____________________ l. ____________________

4. Identify five types of eye protection equipment.



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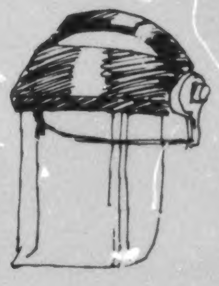

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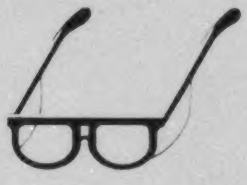

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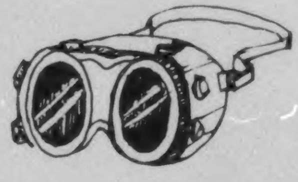

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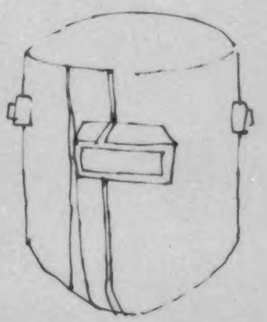


e. ______________________________

5. Name two uses of a bumping hammer.

a.

b.

6. Describe the finger movement when using the body hammer.

7. Describe the finger-wrist movement when using the body hammer.

8. List three uses of dolly blocks.

a.

b.

c.

9. List three uses of body spoons.

a.

b.

c.

10. Describe how faces of dollies, hammers, and spoons should be conditioned.

11. Describe how the teeth of a body file differ from those of a standard file.

12. Demonstrate the ability to:

a. Recondition a finishing hammer.

b. Recondition a dolly block.

c. Recondition a body spoon.

d. Use all body tools safely and correctly.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

BODY HAND TOOLS
UNIT II

ANSWERS TO TEST

1.
   a. Pick hammer
   b. Dinging hammer
   c. Bumping hammer
   d. Cross peen hammer
   e. Shrinking hammer
   f. Magnetic trim hammer
   g. Egg dolly block
   h. Bumping dolly
   i. General purpose or railroad dolly
   j. Loaf dolly block
   k. Toe dolly block
   l. Heel dolly block
   m. Shrinking dolly
   n. Comma or wedge dolly block
   o. Backup and driving spoon
   p. Spring hammering spoon
   q. Body file blade
   r. Straight file holder
   s. Curved file holder
   t. Flexible file holder
   u. Reveal file holder and blades
   v. Bumping or slapping file
   w. Spoon dolly

x. Slide hammer

y. Caulking iron

z. Curved short pick

aa. Curved long pick

bb. Deep throat curved pick

cc. Top rail pick tool

dd. Straight finishing pick

ee. Curved finishing pick

ff. Hooked finishing pick

gg. Body plastic shaping file

hh. Body plastic finishing board file

2. a. Lead paddles

   b. Putty knife or plastic squeeze

3. a. Drip molding pliers

   b. Door and window handle clip remover

   c. Reveal molding clip tool

   d. Windshield knife

   e. Vacuum lifter

   f. Molding clip pliers

   g. Pop rivet gun

   h. Locking strip tool

   i. Door hinge wrench

   j. Bumper bracket tool

   k. Door hinge aligner

   l. Body pull rod set

4. a. Goggles

   b. Safety shield

c. Safety glasses

d. Welding goggles

e. Arc welding helmet

5. a. Roughing out damaged areas

   b. Straightening heavier panels, bumpers, frame rails, and other areas

6. Description should include:

   a. Hold the hammer loosely

   b. Close hand to strike blow

7. Description should include:

   a. Increase your arm angle with the surface so finger movement will end at a twenty or twenty-five degree angle

   b. Add wrist movement to complete the hammer blow to the surface

8. a. To back up or support damaged metal when it is being hammered back into shape

   b. As a striking tool to drive metal into shape

   c. As forming tools to form metal in construction of replacement panels or sections

9. a. In place of dollies

   b. As pry tools to lift low spots

   c. To spring hammer ridges and creases

10. The faces should be kept smooth using sandpaper, emery cloth, and in extreme damage cases, the use of a fine file to remove pits and scratches

11. Deep U-shaped grooves between the teeth allow shavings to escape and prevent plugging

12. Performance skills will be evaluated according to the criteria listed on the progress chart.

POWER TOOLS AND EQUIPMENT
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to identify the power tools and equipment used in automotive body shops. He should be able to use all equipment safely and properly. This knowledge will be evidenced through demonstration and by scoring one-hundred percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify hand operated power tools.
2. Identify items of power equipment.
3. List the four components of the hydraulic jack.
4. Match a list of operations or jobs to power tools.
5. Complete ten general safety rules concerning power tools.
6. Complete safety rules for power tools.
    a. Portable power sander or polisher
    b. Hydraulic jack equipment (4 and 10 ton body jacks)
    c. Drill (portable)
    d. Pneumatic air hammer
    e. Heat gun
    f. Bench grinder
    g. Drill press
    h. Arc welder
    i. Service jack
    j. Front end lift
    k. Safety stands
    l. Frame equipment
7. Demonstrate the ability to use all power tools and equipment safely and correctly.

POWER TOOLS AND EQUIPMENT
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Emphasize the importance of using all power tools and equipment safely and correctly.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to use all power tools and equipment safely and correctly.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1--Hand Operated Power Tools

      2. TM 2--Hand Operated Power Tools (Continued)

      3. TM 3--Power Equipment

4. TM 4--Power Equipment (Continued)

5. TM 5--Power Equipment (Continued)

6. TM 6--Power Equipment (Continued)

7. TM 7--Power Equipment (Continued)

8. TM 8--Power Equipment (Continued)

D. Test

E. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

B. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

C. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

D. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

POWER TOOLS AND EQUIPMENT
UNIT III

INFORMATION SHEET

I. Hand operated power tools (Transparencies 1 and 2)

   A. Pneumatic grinder

   B. Electric grinder

   C. Pneumatic polisher

   D. Pneumatic drill

   E. Pneumatic hammer

   F. Orbital sander

   G. Pneumatic file

   H. Pneumatic oscillating sander

   I. Impact wrench

   J. Metal shear

   K. Bench grinder

   L. 1/2" electric drill

   M. 1/4" electric drill

   N. Cable pull unit

   O. Electric polisher

II. Items of power equipment (Transparencies 3, 4, 5, 6, 7, and 8)

   A. Portable frame and body straightening unit

   B. Stationary frame and body straightening rack

   C. Channel mount frame and body straightening unit

   D. Vacuum mount body pull post

   E. Tie down with pull post body and frame straightening system

   F. Mechanical body jack set

   G. Hydraulic body jack set

   H. Pneumatic hydraulic pump

INFORMATION SHEET

- I. Spred ram
- J. Wedge ram
- K. Drill press
- L. Vacuum cleaner
- M. Car wash and steam cleaning system
- N. Service jack
- O. One-end lift
- P. Hand jack
- Q. Safety stand
- R. AC/DC arc welder
- S. MIG welder

III. Components of the hydraulic jack

- A. Pump
- B. Hose
- C. Ram
- D. Attachments

IV. Basic operation of power tools

- A. Portable grinder
  - 1. Removes paint
  - 2. Buffs and grinds metal
  - 3. Grinds welds
- B. Polisher--Polishes paint
- C. Drill--Electric or pneumatic
  - 1. Drills and bores
  - 2. Cleans metal using wire brush attachment
- D. Pneumatic hammer
  - 1. Cuts spot welds
  - 2. Removes panels
  - 3. Chisels
  - 4. Rivets

INFORMATION SHEET

E. Orbital sander
  1. Smoothes metal
  2. Featheredges paint
  3. Sands paint

F. Pneumatic file--Finishes plastic filler

G. Oscillating sander
  1. Featheredges paint
  2. Sands paint

H. Impact wrench--Loosens and tightens bolts

I. Metal shear--Cuts sheet metal

J. Bench grinder
  1. Dresses punches and chisels
  2. Sharpens drill bits
  3. Grinds metals

K. Cable pull unit
  1. Aligns body panels
  2. Lifts heavy objects

L. Body and frame straightening equipment
  1. Aligns body parts
  2. Aligns and straightens frames

M. Body jack equipment
  1. Aligns body parts
  2. Straightens frame members

N. Drill press--Drills and bores holes

O. Vacuum cleaner
  1. Picks up dirt and dust
  2. Picks up liquids (Wet-vac only)

INFORMATION SHEET

- P. Car wash and steam cleaning equipment
    - 1. Washes vehicles
    - 2. Cleans engines and under body areas
- Q. Service jack and end lift--Raise vehicle to gain access to underside
- R. Safety stands--Secure vehicle when lifted so it will be safe under which to work
- S. Arc welder
    - 1. Welds frame members and rails
    - 2. Welds body panels (MIG)
    - 3. Spot welds (MIG)

V. General safety rules

- A. Always wear goggles when using a power tool
- B. Lift and carry heavy and/or bulky objects safely
- C. Only the operator is permitted inside the safety lanes around a machine
- D. Do not look around or attempt to carry on a conversation while operating a power tool
- E. Wear appropriate clothing for the job
- F. Make sure that all power tools are properly grounded before using
- G. Assume a safe and comfortable position before using a power tool
- H. Use a power tool only for its intended use
- I. Do not use a dull or broken tool
- J. Have all special set-ups checked by the instructor

VI. Safety rules for power tools

- A. Portable power sander or polisher
    - 1. Locate the on-off switch
    - 2 Keep a firm grip on the sander at all times
    - 3. Make sure hands and feet are dry before using power sander or polisher

INFORMATION SHEET

4. Be sure the tool is properly grounded
5. Before changing a disc or bonnet, unplug the machine
6. Do not wear loose fitting clothes; keep shirttails in while grinding or polishing
7. Keep power cord away from disc or bonnet
8. Use proper sanding techniques; do not sand into the edge of metal, chrome, and other parts which are attached to the body
9. Wear safety goggles when grinding
10. Warn others around you when you are going to use a sander or polisher
11. Lay sander or polisher on floor before connecting to the power source
12. Start a sander or polisher off the surface and stop it on the surface

B. Hydraulic jack equipment (4 and 10 ton body jacks)

1. Locate the pressure release valve
2. Make sure the jack is properly anchored when in use
3. Do not grab a ruptured hydraulic line or hose
4. Wear gloves at all times when using hydraulic body jack equipment
5. Stand away from equipment when applying pressure
6. Use proper jacking techniques to prevent bodily injury and damage to the equipment

C. Drill (portable)

1. Locate the on-off switch
2. Keep a firm grip on the drill at all times
3. Make sure hands and feet are dry before using power drill
4. Be sure the tool is properly grounded
5. Tighten bit securely in the drill chuck
6. Wear safety goggles when using a wire brush in the drill
7. Do not leave chuck wrench in chuck when using the drill

INFORMATION SHEET

D. Pneumatic air hammer

1. Do not exceed recommended air pressure when using pneumatic hammer
2. Do not pull trigger when bit is not against the surface
3. Wear gloves when operating an air hammer

E. Heat gun

1. Do not heat surfaces which will melt at low temperatures or are made of glass
2. Do not touch heated surfaces
3. Let heat gun cool before turning off fan motor

F. Bench grinder

1. Keep tool rest set within one-eighth inch from the wheel or brush
2. Wear safety goggles when using the bench grinder
3. Do not grind anything against the side of the grinding wheel
4. Wear gloves when grinding
5. Do not stand directly in the plane of the turning grinding wheel

G. Drill press

1. Do not leave chuck wrench in chuck when using the drill press
2. Secure your work to the table before drilling
3. Keep hands clear of the turning chuck and bit
4. Use proper drill press operating techniques

H. Arc welder

1. Wear proper safety clothing when using the arc welder: gloves, apron, shoes, and heavy long-sleeved shirt
2. Wear an arc welding hood when welding
3. Warn others around you before striking an arc

INFORMATION SHEET

4. Examine your work and the work area around you for inflammables before striking an arc
5. Use proper arc welding techniques when welding

I. Service jack

1. Place jack under designated jack points before lifting the vehicle
2. Do not get under or remove parts until safety stands have been properly installed
3. Warn others before letting a vehicle down on the floor
4. Do not exceed the specified weight limits of the jack when lifting vehicles
5. Do not leave vehicle on the jack overnight; release the jack allowing vehicle to rest on safety stands

J. Front end lift

1. Place lift under proper lifting points before raising the vehicle
2. Set safety catch at level to which car is raised
3. Do not get under or remove parts until safety stands have been properly installed
4. Warn others before lowering a vehicle down on the floor
5. Place vehicle in neutral with emergency brake released before lifting the front end
6. Do not exceed specified lift limits of the front end lift

K. Safety stands

1. Inspect all safety stands for damaged catches and cracks in the legs and braces before using them
2. Place safety stands in proper areas before letting the vehicle rest on them

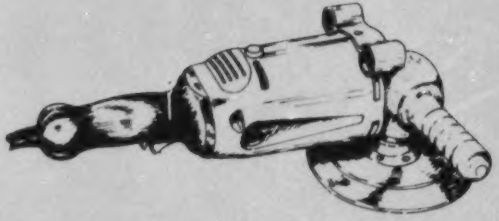
L. Frame equipment

1. Anchor the vehicle properly
2. Check all chain links and hooks before using them to anchor or pull

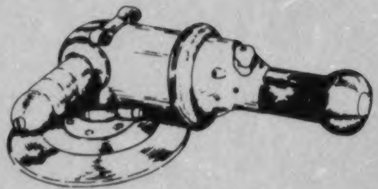
INFORMATION SHEET

3. Install all clamps properly
4. Do not stand in the plane or in front of the pull arm when pulling out damage
5. Do not heat chain or hook fastening areas
6. Inspect constantly all hooks and anchor areas when pulling
7. Cover chain with fender cover when making pulls
8. Wear gloves when handling chains and hooks
9. Warn others when pulling is in progress
10. Locate release valve on hydraulic equipment
11. Use proper techniques when operating frame equipment

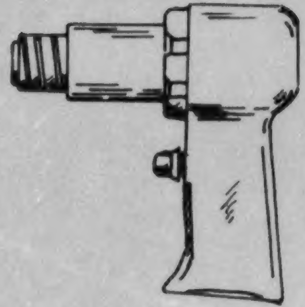
Hand Operated Power Tools



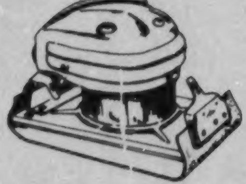
Electric Grinder



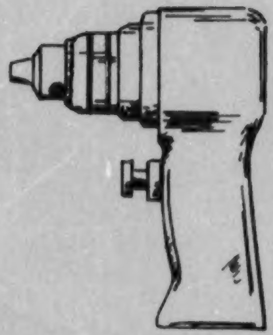
Pneumatic Grinder



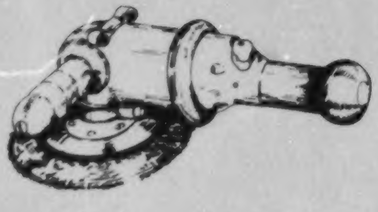
Pneumatic Hammer



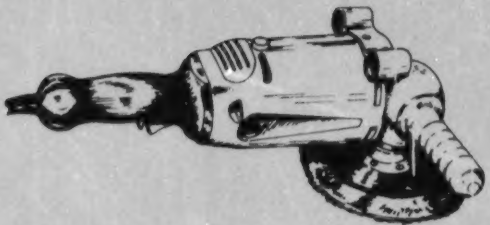
Orbital Sander



Pneumatic Drill



Pneumatic Polisher



Electric Polisher

Hand Operated Power Tools

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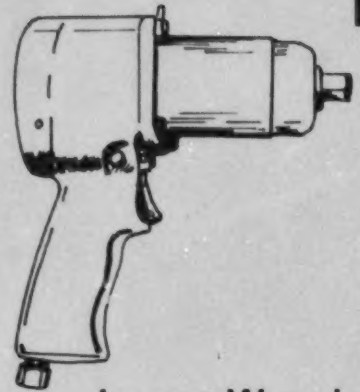
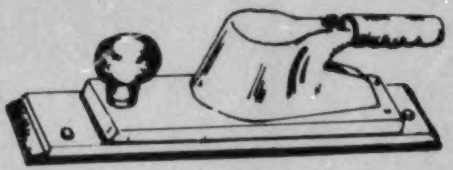
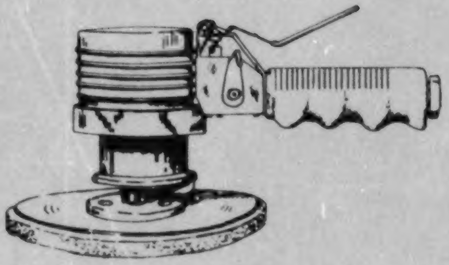


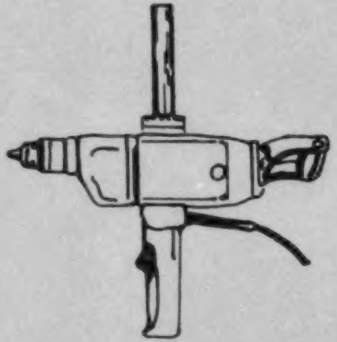
Impact Wrench



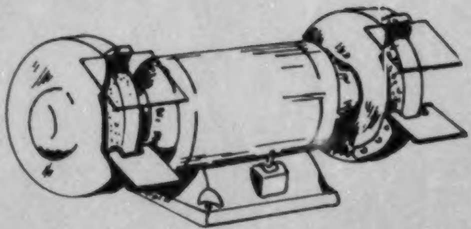
Pneumatic File



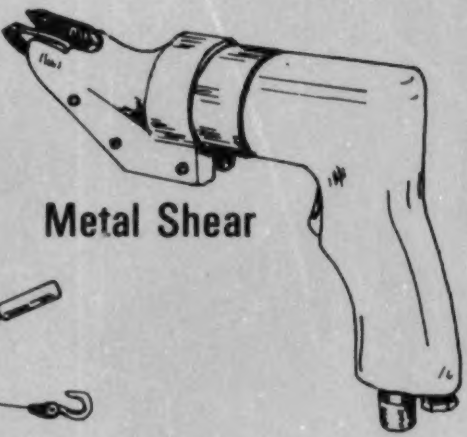
Pneumatic Oscillating Sander



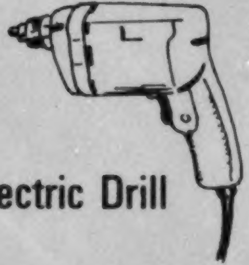
½" Electric Drill



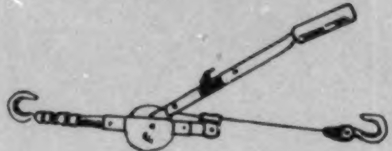
Bench Grinder



Metal Shear

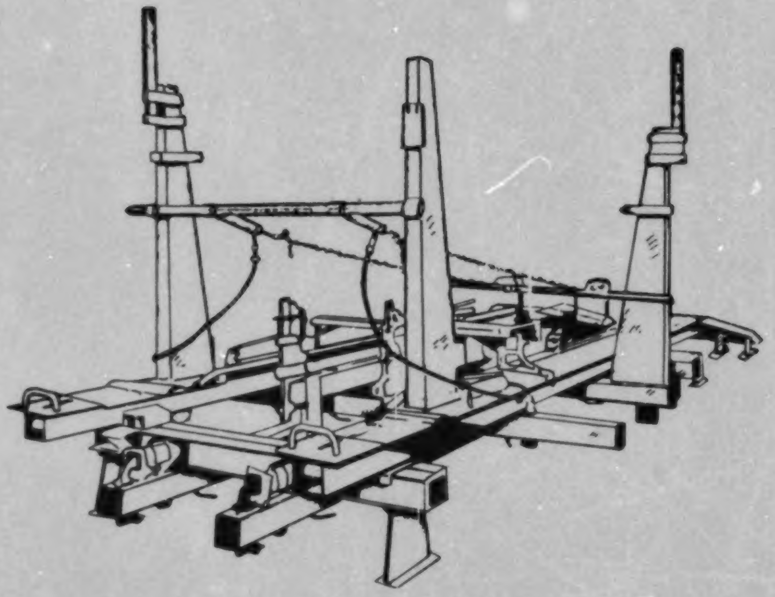


¼" Electric Drill

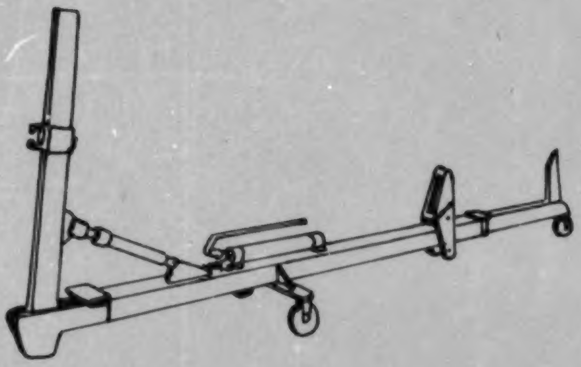


Cable Pull Unit

Power Equipment



Stationary Frame and Body
Straightening Rack



Portable Frame and Body
Straightening Unit

Power Equipment

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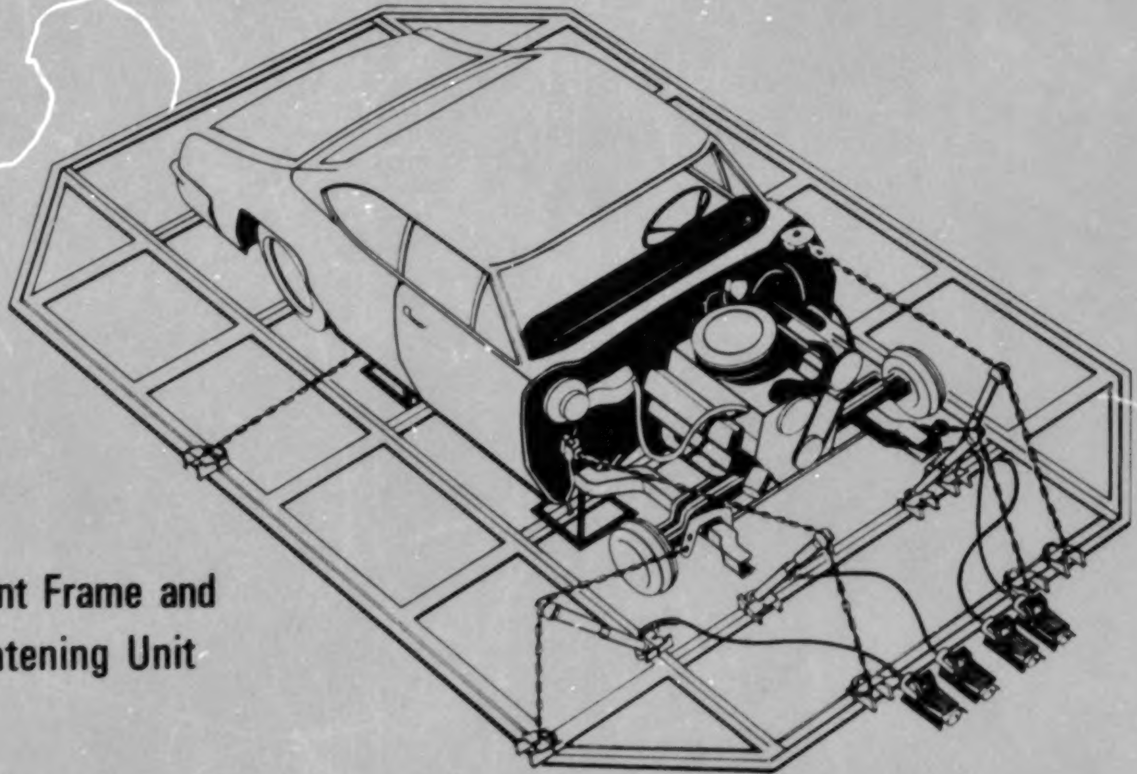

Channel Mount Frame and
Body Straightening Unit

Power Equipment

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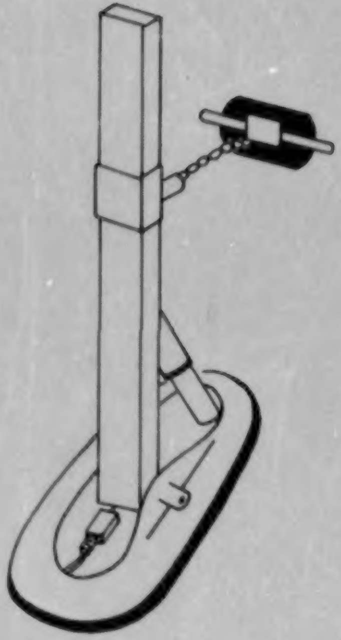
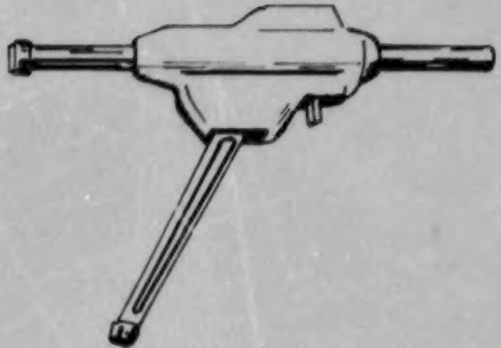
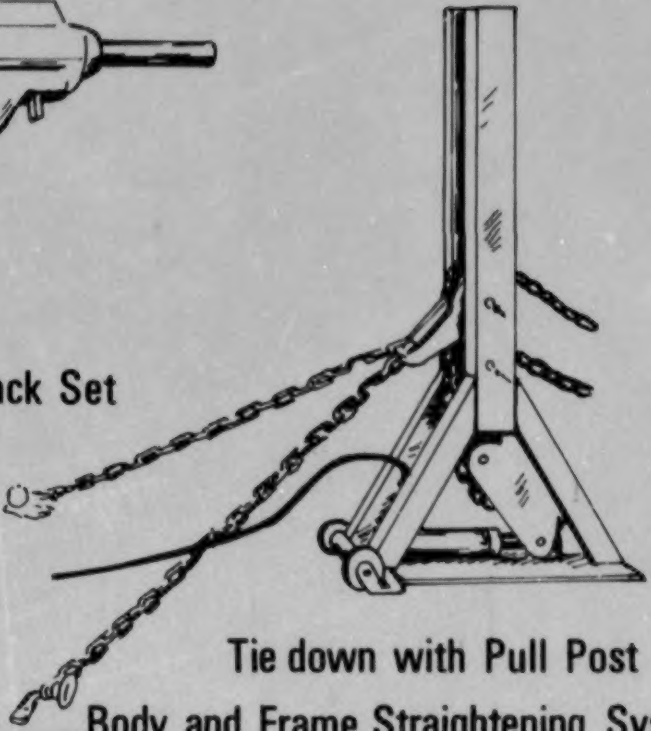


Vacuum Mount Body Pull Post



Mechanical Body Jack Set



Tie down with Pull Post

Body and Frame Straightening System

Power Equipment

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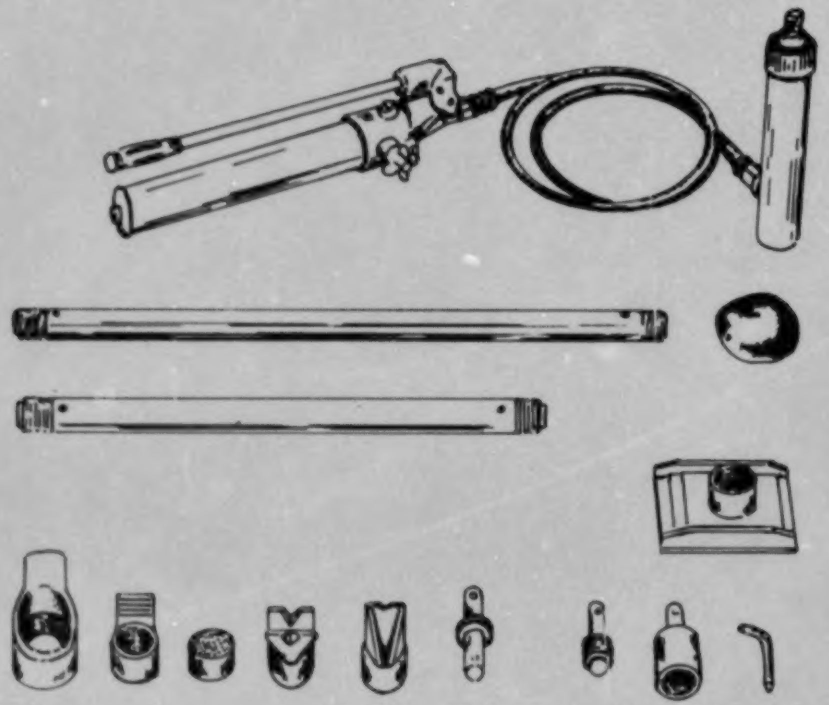
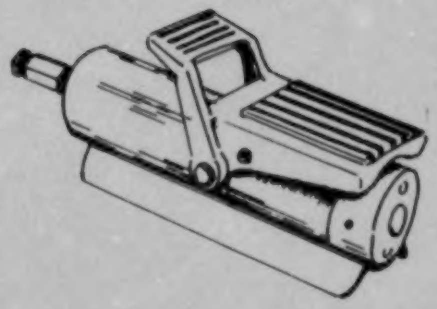


Hydraulic Body Jack Set



Pneumatic Hydraulic Pump

Power Equipment

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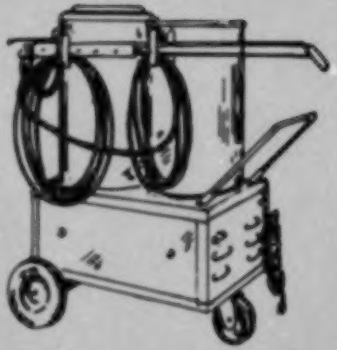
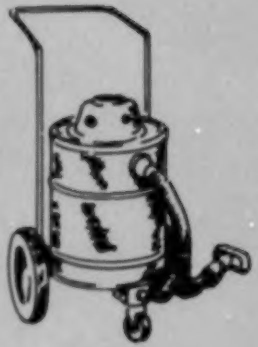
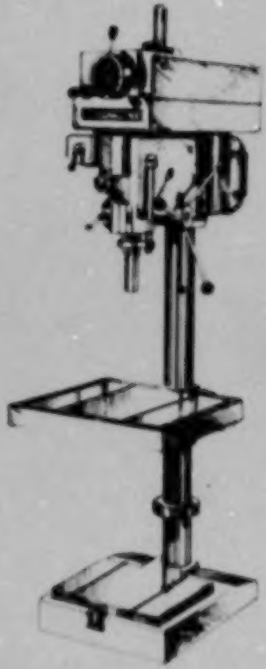


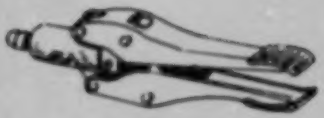
Car Wash and
Steam Cleaning
System



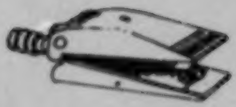
Vacuum Cleaner



Drill Press



Spred Ram



Wedge Ram

Power Equipment

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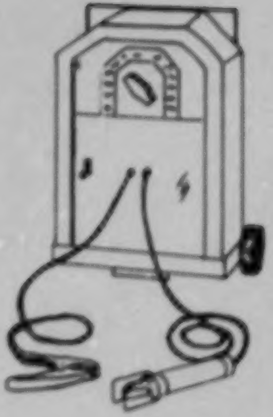
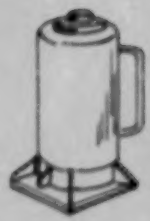
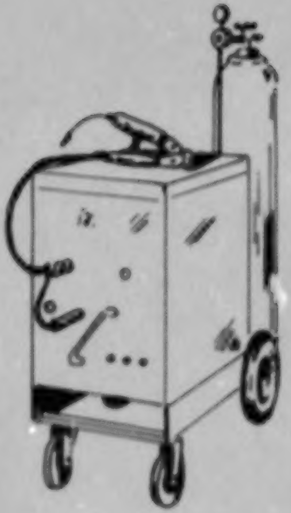


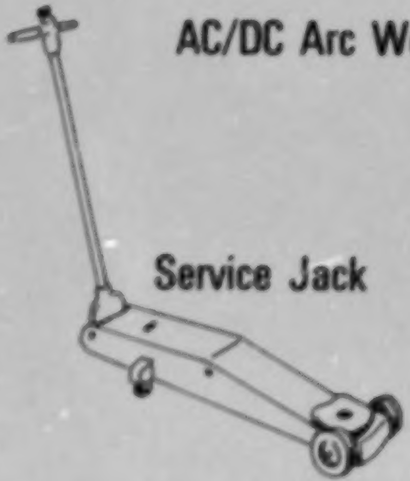
AC/DC Arc Welder



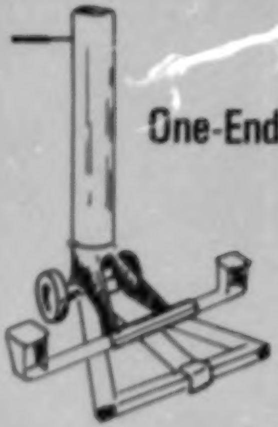
Hand Jack



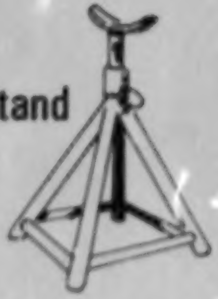
MIG Welder



Service Jack



One-End Lift

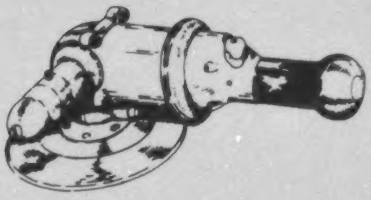


Safety Stand

POWER TOOLS AND EQUIPMENT
UNIT III

TEST

1. Identify hand operated power tools.



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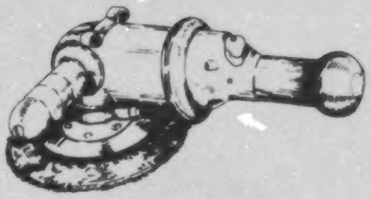
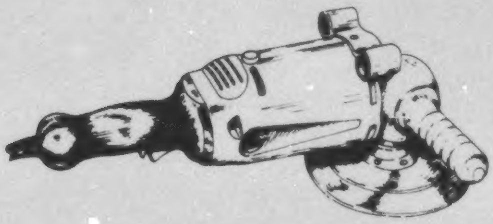
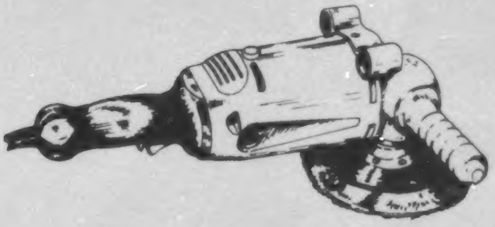


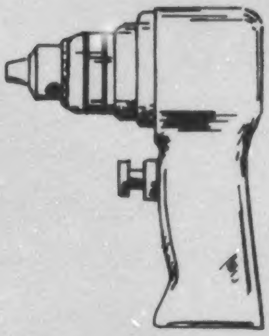
b. ______________________



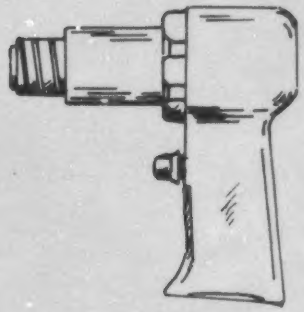
c. ______________________



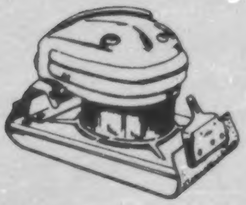
d. ______________________

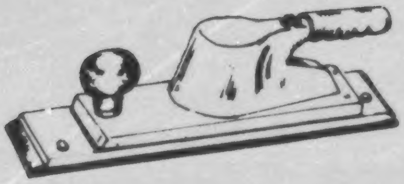


e. ______________________



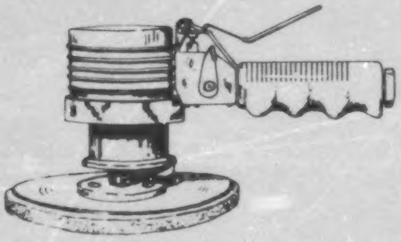
f. ______________________

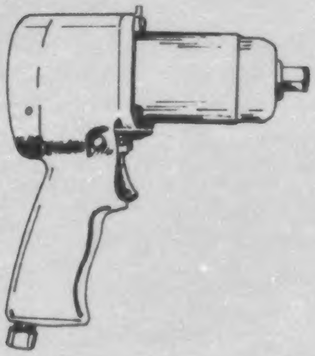




g. ______________________

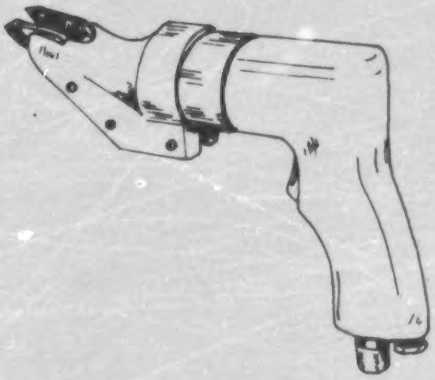
h. ______________________

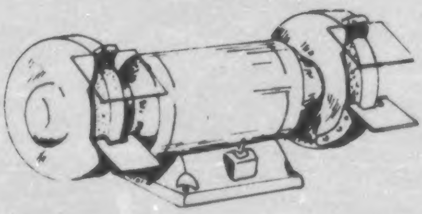




i. ______________________

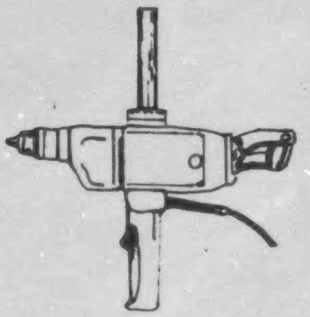
j. ______________________

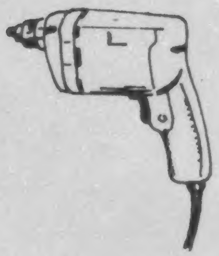




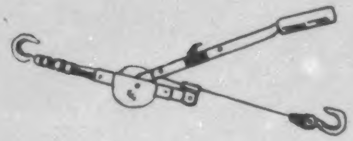
k. ______________________

l. ______________________



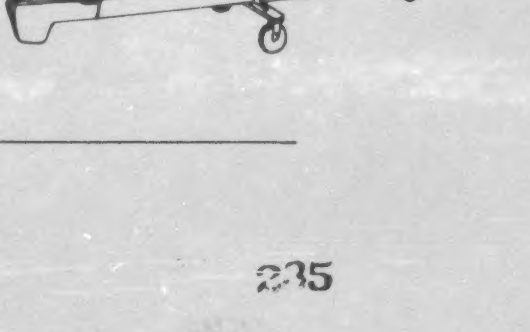


m. ______________________________ n. ______________________________

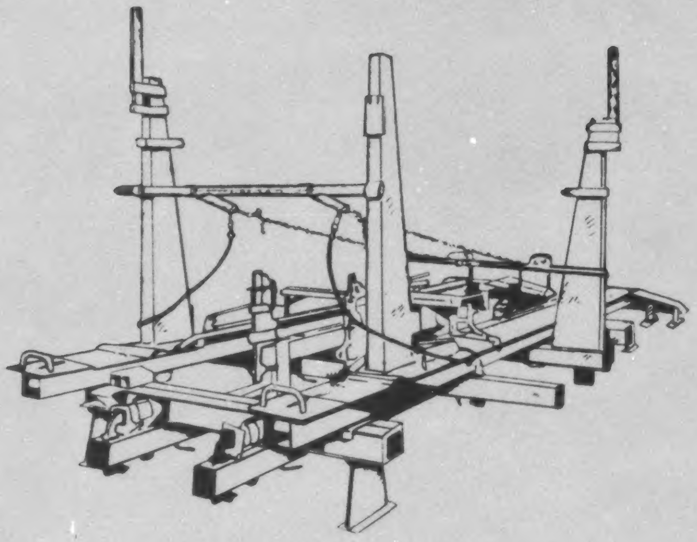


o. ______________________________

2. Identify items of power equipment.



a. ______________________________



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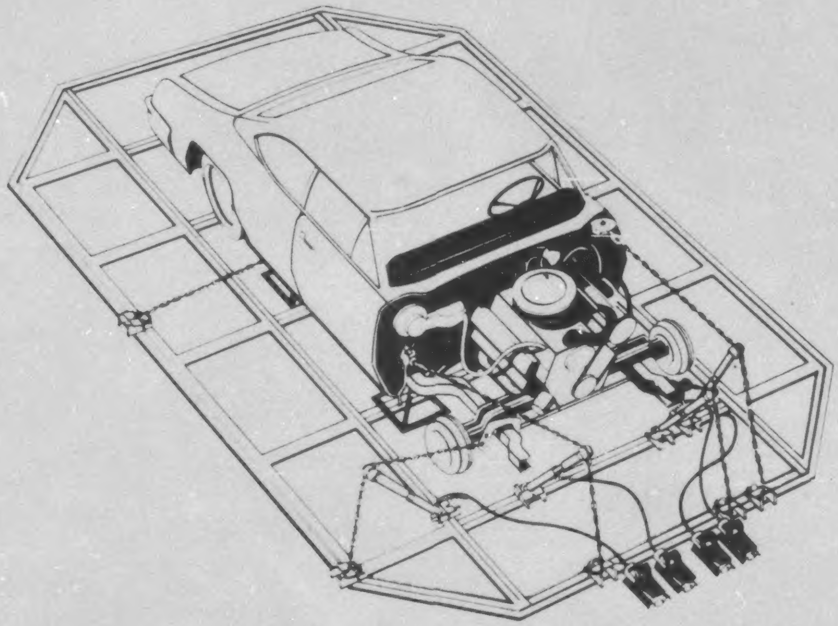

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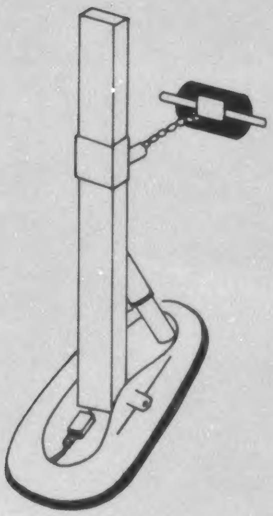

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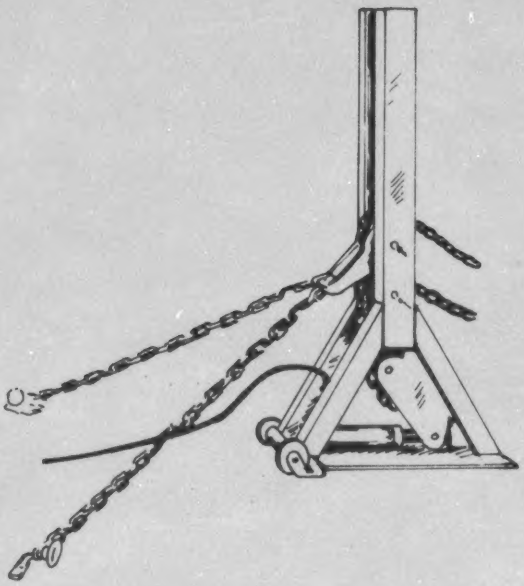

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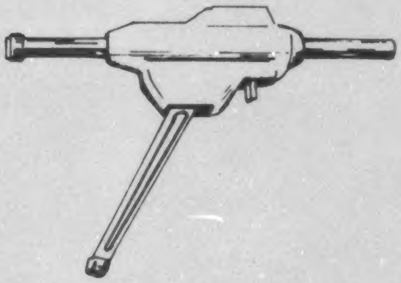

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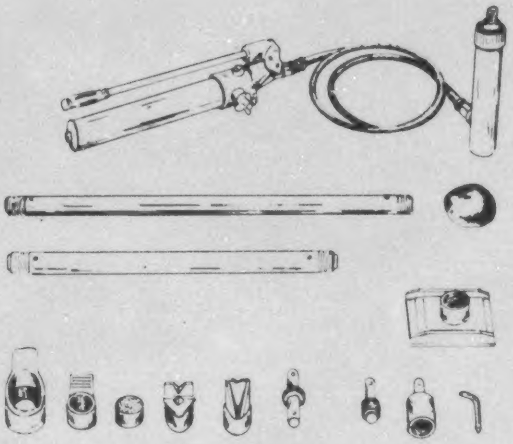

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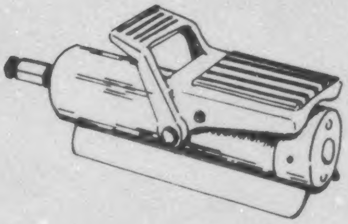

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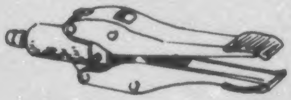

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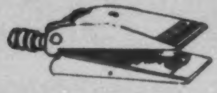

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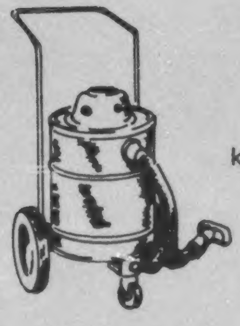

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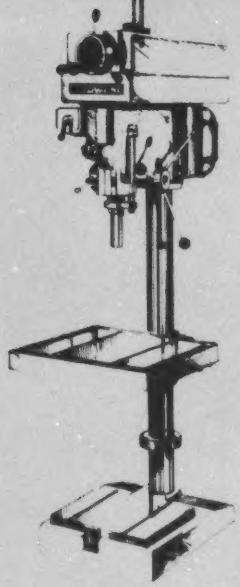

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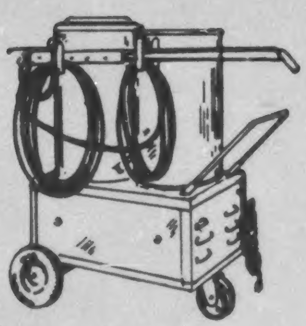

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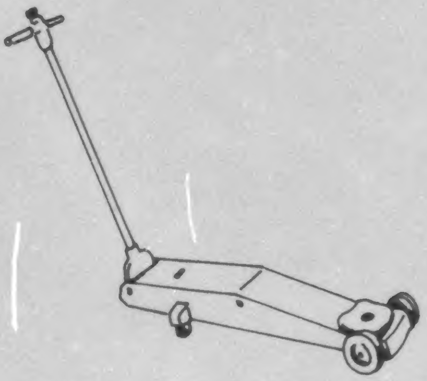

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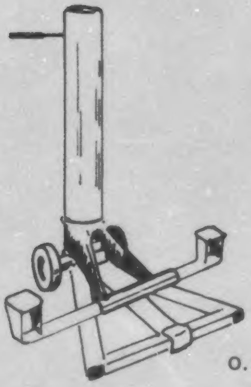
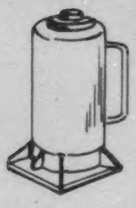
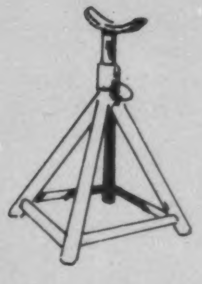


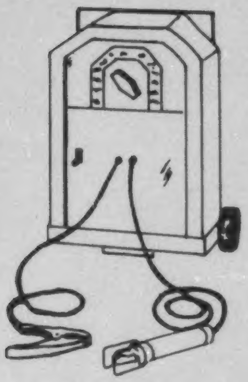
o. ______________________________



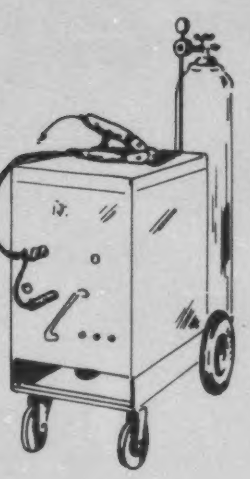
p. ____________________



q. ____________________



r. ____________________



s. ____________________

3. List the four components of the hydraulic jack.

   a.

   b.

   c.

   d.

4. Match a list of operations or jobs to power tools. (Continued on next page)

   _____a. Buffs and grinds metal

   _____b. Polishes paint

   _____c. Cleans metal using wire brush attachment

   1. Car wash and steam cleaning equipment
   2. Bench grinder
   3. Impact wrench

_____d. Cuts spot welds

_____e. Smoothes metal

_____f. Finishes plastic filler

_____g. Featheredges paint

_____h. Loosens and tightens bolts

_____i. Cuts sheet metal

_____j. Dresses punches and chisels

_____k. Lifts heavy objects

_____l. Aligns and straightens frames

_____m. Aligns body parts

_____n. Drills and bores holes

_____o. Picks up dirt and dust

_____p. Washes vehicles

_____q. Raise vehicles to gain access to underside

_____r. Secure vehicle when lifted so it will be safe under which to work

_____s. Welds body panels

4. Orbital sander
5. Safety stands
6. Pneumatic hammer
7. Body and frame straightening equipment
8. Polisher
9. Arc welder
10. Pneumatic file
11. Portable grinder
12. Service jack and end lift
13. Drill--Electric or pneumatic
14. Oscillating sander
15. Cable pull unit
16. Metal shear
17. Vacuum cleaner
18. Drill press
19. Body jack equipment

5. Complete ten general safety rules.

a. Always wear ________________ when using a power tool.

b. ________________ and ________________ heavy and/or bulky objects safely.

c. Only the ________________ is permitted inside the safety lanes around a machine.

d. Do not ___________ ___________ or attempt to carry on a ________________ while operating a power tool.

e. Wear appropriate ________________ for the job.

f. Make sure that all power tools are properly ________________ before using.

g. Assume a ________________ and ________________ position before using a power tool.

h. Use a power tool only for its ________________ use.

i. Do not use a ________________ or ________________ tool.

j. Have all ________________ set-ups checked by the instructor.

6. Complete safety rules for power tools.

a. Portable power sander or polisher

1) Locate the ________________ switch.

2) Keep a firm ________________ on the sander at all times.

3) Make sure ________________ and ________________ are dry before using power sander or polisher.

4) Be sure the tool is properly ________________.

5) Before changing a disc or bonnet, ________________ the machine.

6) Do not wear ________________ fitting clothes, keep shirttails in while grinding or polishing.

7) Keep power ________________ away from disc or bonnet.

8) Use proper sanding ________________; do not sand into the ________________ of metal, chrome, and other parts which are attached to the body.

9) Wear safety ________________ when grinding.

10) ________________ others around you when you are going to use a sander or polisher.

11) Lay sander or polisher on ________________ before connecting to the ________________ source.

12) Start a sander or polisher ________________ the surface and stop it ________________ the surface.

b. Hydraulic jack equipment (4 and 10 ton body jacks)

1) Locate the pressure ________________ valve.

2) Make sure the jack is properly ________________ when in use.

3) Do not ________________ a ruptured hydraulic line or hose.

4) Wear ________________ at all times when using hydraulic body jack equipment.

5) Stand ________________ from equipment when applying pressure.

6) Use proper jacking ________________ to prevent bodily injury and damage to equipment.

c. Drill (portable)

1) Locate the ________________ switch.

2) Keep a firm ________________ on the drill at all times.

3) Make sure ________________ and ________________ are dry before using power drill.

4) Be sure tool is properly ________________.

5) Tighten bit ________________ in the drill chuck.

6) Wear safety ________________ when using a wire brush in the drill.

7) Do not leave the ____________ ____________ in chuck when using the drill.

d. Pneumatic air hammer

1) Do not exceed recommended air ________________ when using pneumatic hammer.

2) Do not pull ________________ when bit is not against the surface.

3) Wear ________________ when operating air hammer.

e. Heat gun

1) Do not heat surfaces which will melt at low ________________ or are made of ________________.

2) Do not ________________ heated surfaces.

3) Let heat gun ________________ before turning off fan motor.

f. Bench grinder

1) Keep tool ________________ set within one-eighth inch from wheel or brush.

2) Wear safety ________________ when using the bench grinder.

3) Do not grind anything against the ________________ of the grinding wheel.

4) Wear ________________ when grinding.

5) Do not stand directly in the ________________ of the turning grinding wheel.

g. Drill press

1) Do not leave chuck ________________ in ________________ when using the drill press.

2) Secure your ________________ to the table before drilling.

3) Keep hands ________________ of the turning chuck and bit.

4) Use proper drill press operating ________________.

h. Arc welder

1) Wear proper ________________ clothing when using the arc welder: gloves, apron, shoes, and heavy long-sleeved shirt.

2) Wear an arc welding ________________ when welding.

3) Warn others around you before ________________ an arc.

4) Examine your work and the work area around you for ________________ before striking an arc.

5) Use proper arc welding ________________ when welding.

i. Service jack

1) Place jack under designated jack ________________ before lifting the vehicle.

2) Do not get ________________ or ________________ parts until safety stands have been properly installed.

3) ________________ others before letting a vehicle down on the floor.

4) Do not exceed the specified weight ________________ of the jack when lifting vehicles.

5) Do not leave ________________ on the jack overnight; release the jack allowing vehicle to rest on safety stands.

j. Front end lift

1) Place lift under proper ________________ points before raising the vehicle.

2) Set safety ________________ at level to which car is raised.

3) Do not get ________________ or ________________ parts until safety stands have been properly installed.

4) ________________ others before lowering a vehicle down on the floor.

5) Place vehicle in ________________ with ____________ __________ released before lifting the front end.

6) Do not exceed ________________ lift limits of the front end lift.

k. Safety stands

1) Inspect all safety stands for damaged ________________ and ________________ in the legs and braces before using them.

2) Place safety stands in proper ________________ before letting the vehicle rest on them.

l. Frame equipment

1) ________________ the vehicle properly.

2) Check all chain ________________ and ________________ before using them to anchor or pull.

3) Install all clamps ________________.

4) Do not stand in the ________________ or in front of the pull arm when pulling out damage.

5) Do not ________________ chain or hook fastening areas.

6) Inspect constantly all ________________ and ________________ areas when pulling.

7) Cover ________________ with fender covers when making pulls.

8) Wear ________________ when handling chains and hooks.

9) ________________ others when pulling is in progress.

10) Locate ________________ valve on hydraulic equipment.

11) Use proper ________________ when operating frame equipment.

7. Demonstrate the ability to use all power tools and equipment safely and correctly.

POWER TOOLS AND EQUIPMENT
UNIT III

ANSWERS TO TEST

1. a. Pneumatic grinder
   b. Pneumatic polisher
   c. Electric grinder
   d. Electric polisher
   e. Pneumatic drill
   f. Pneumatic hammer
   g. Orbital sander
   h. Pneumatic file
   i. Pneumatic oscillating sander
   j. Impact wrench
   k. Metal shear
   l. Bench grinder
   m. 1/2" electric drill
   n. 1/4" electric drill
   o. Cable pull unit
2. a. Portable frame and body straightening unit
   b. Stationary frame and body straightening rack
   c. Channel mount frame and body straightening unit
   d. Vacuum mount body pull post
   e. Tie down with pull post body and frame straightening system
   f. Mechanical body jack set
   g. Hydraulic body jack set
   h. Pneumatic hydraulic pump
   i. Spred ram
   j. Wedge ram
   k. Vacuum cleaner
   l. Drill press

m. Car wash and steam cleaning system
n. Service jack
o. One-end lift
p. Hand jack
q. Safety stand
r. AC/DC arc welder
s. MIG welder

3. a. Pump
b. Hose
c. Ram
d. Attachments

4. a. 11
b. 8
c. 13
d. 6
e. 4
f. 10
g. 14
h. 3
i. 16
j. 2
k. 15
l. 7
m. 19
n. 18
o. 17
p. 1
q. 12
r. 5
s. 9

5. a. Goggles
   b. Lift, carry
   c. Operator
   d. Look around, conversation
   e. Clothing
   f. Grounded
   g. Safe, comfortable
   h. Intended
   i. Dull, broken
   j. Special
6. a. 1) On-off
      2) Grip
      3) Hands, feet
      4) Grounded
      5) Unplug
      6) Loose
      7) Cord
      8) Techniques, edge
      9) Goggles
      10) Warn
      11) Floor, power
      12) Off, on
   b. 1) Release
      2) Anchored
      3) Grab
      4) Gloves
      5) Away
      6) Techniques
   c. 1) On-off
      2) Grip
      3) Hands, feet

4) Grounded
5) Securely
6) Goggles
7) Chuck wrench

d. 1) Pressure
2) Trigger
3) Gloves

e. 1) Temperatures, glass
2) Touch
3) Cool

f. 1) Rest
2) Goggles
3) Side
4) Gloves
5) Plane

g. 1) Wrench, chuck
2) Work
3) Clear
4) Techniques

h. 1) Safety
2) Hood
3) Striking
4) Inflammables
5) Techniques

i. 1) Points
2) Under, remove
3) Warn
4) Limits
5) Vehicle

j. 1) Lifting
  2) Catch
  3) Under, remove
  4) Warn
  5) Neutral, emergency brake
  6) Specified

k. 1) Catches, cracks
  2) Areas

l. 1) Anchor
  2) Links, hooks
  3) Properly
  4) Plane
  5) Heat
  6) Hooks, anchor
  7) Chain
  8) Gloves
  9) Warn
  10) Release
  11) Techniques

7. Performance skills will be evaluated according to the criteria listed on the progress chart.

REFINISHING EQUIPMENT
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to identify the various types of refinishing equipment. He should be able to clean a spray gun, pressure pot, and airless system, drain an air regulator, and drain and service an air compressor. This knowledge will be evidenced through demonstration and by scoring one-hundred percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify the types of refinishing equipment used in auto body refinishing.
2. Complete six general safety rules concerning paint equipment.
3. Demonstrate the ability to:
    a. Clean a paint gun.
    b. Clean a pressure pot.
    c. Clean an airless spray system.
    d. Drain an air regulator (transformer).
    e. Drain and service an air compressor.

REFINISHING EQUIPMENT
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedure outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1--Refinishing Equipment

      2. TM 2--Refinishing Equipment (Continued)

      3. TM 3--Refinishing Equipment (Continued)

      4. TM 4--Refinishing Equipment (Continued)

D. Job sheets

   1. Job Sheet #1--Clean a Paint Gun
   2. Job Sheet #2--Clean a Pressure Pot
   3. Job Sheet #3--Clean an Airless Spray System
   4. Job Sheet #4--Drain an Air Regulator (Transformer)
   5. Job Sheet #5--Drain and Service an Air Compressor

E. Test

F. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Co., 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

REFINISHING EQUIPMENT
UNIT IV

INFORMATION SHEET

I. Refinishing equipment (Transparencies 1, 2, 3, and 4)

  A. Paint gun
  B. Paint cup, lid, and syphon tube
  C. Air regulator with water trap
  D. Blow gun
  E. Air hose
  F. Paint mask
  G. Air brush
  H. Pressure pot
  I. Apron taper
  J. Orbital sander
  K. Oscillating sander
  L. Sanding block
  M. Air compressor
  N. Viscosity cup
  O. Air dryer
  P. Airless spray system
  Q. Paint booth
  R. Draft gauge
  S. Panel drying system
  T. Spot repair drying system

II. General safety rules concerning paint equipment

  A. Always wear masks (respirators) when spraying
  B. Do not use compressed air to dry skin or remove dust from skin or clothes

INFORMATION SHEET

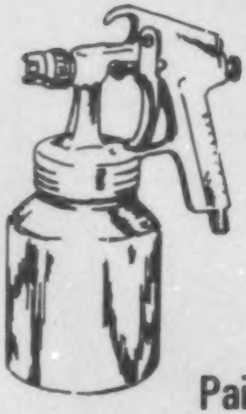
C. Wear appropriate clothing for the job

D. Use paint equipment only for its intended use

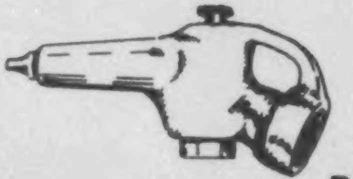
E. Do not place hand over the outlet (nozzles) of any spray equipment when spraying

F. Do not make repairs or service equipment unless all electric power has been turned off

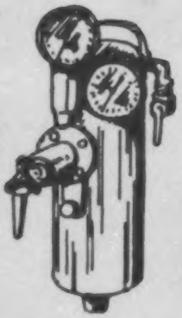
Refinishing Equipment



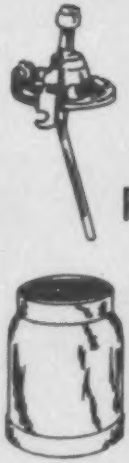
Paint Gun



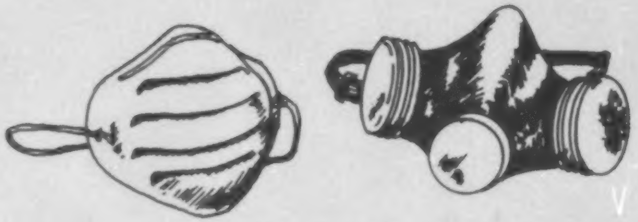
Blow Gun



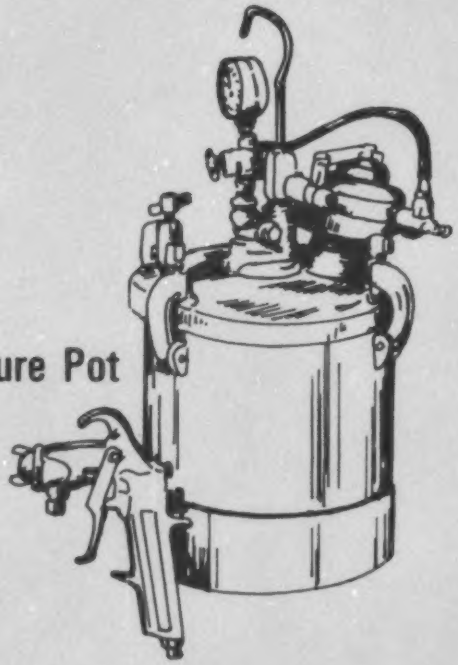
Air Regulator with
Water Trap



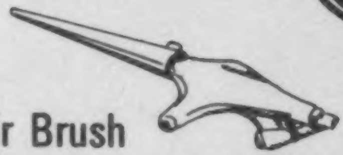
Paint Cup
and Syphon
Tube



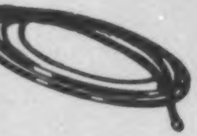
Paint Masks



Paint Pressure Pot



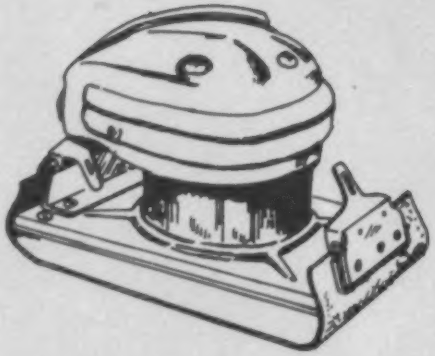
Air Brush



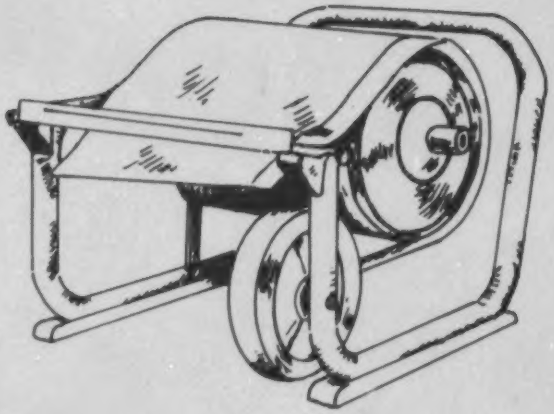
Air Hose

Refinishing Equipment

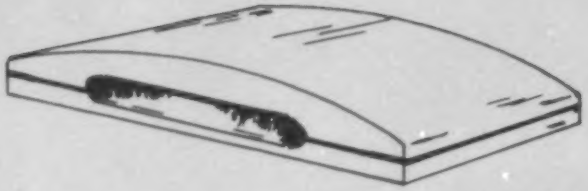
(Continued)



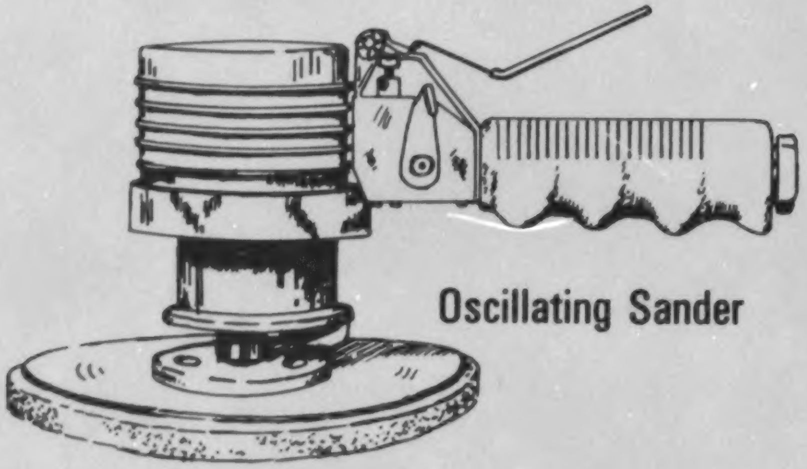
Orbital Sander



Apron Taper



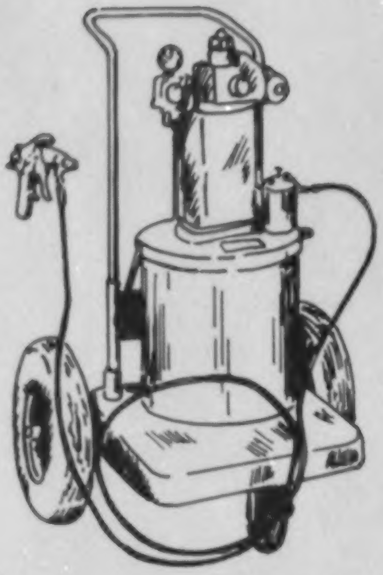
Sanding Block



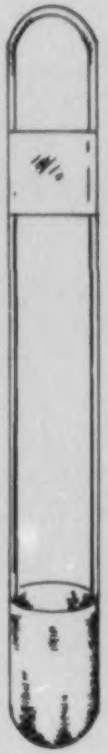
Oscillating Sander

Refinishing Equipment

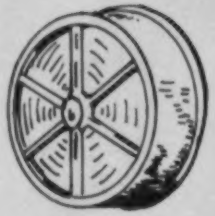
(Continued)



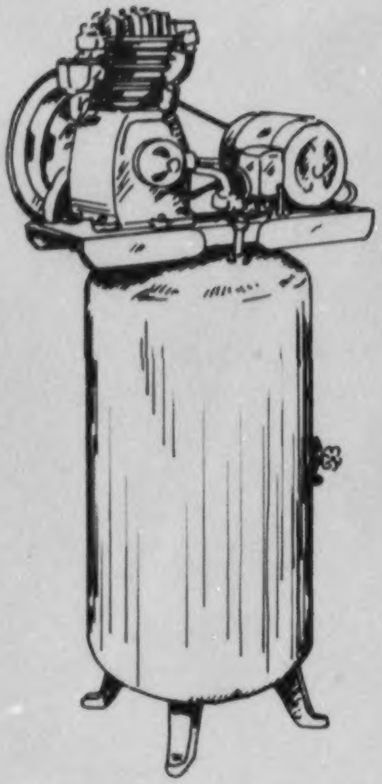
Airless Spray System



Viscosity Cup



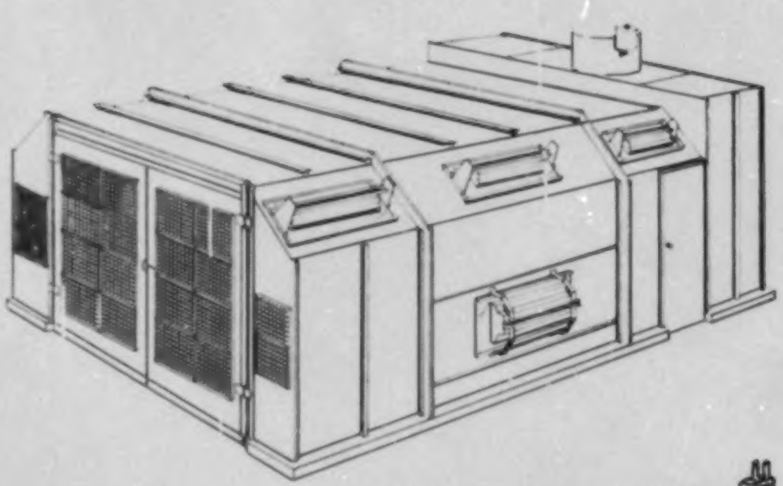
Air Dryer



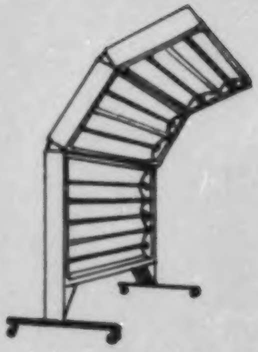
Air Compressor

Refinishing Equipment

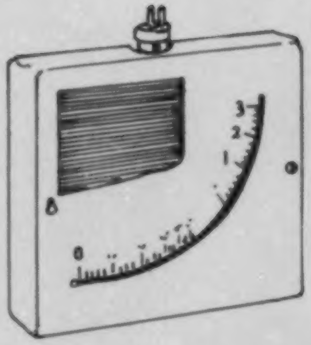
(Continued)



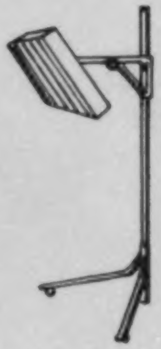
Paint Booth



Panel Drying System



Draft Gauge



Spot Repair Drying System

REFINISHING EQUIPMENT
UNIT IV

JOB SHEET #1--CLEAN A PAINT GUN

I. Tools, equipment, and materials needed

  A. Paint gun

  B. Gun wrench

  C. Air hose

  D. Air regulator

  E. Air compressor

  F. Air connectors

  G. Clean shop clothes

  H. Lacquer thinner or gun cleaner

  I. Round wood toothpick

  J. Gun brushes

II. Procedure

  A. Remove cup from gun

    1. Pour out contents

    (NOTE: Do not pour mixed materials with unmixed materials.)

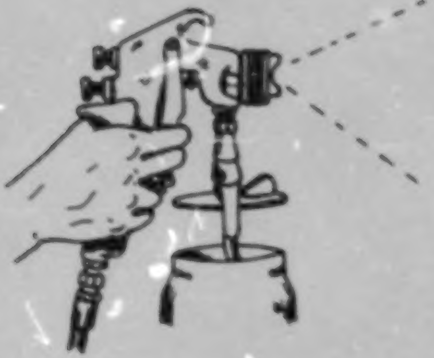
    2. Pour one inch lacquer thinner into cup

  B. Install cup on gun

JOB SHEET #1

C. Spray lacquer thinner through gun (Figure 1)

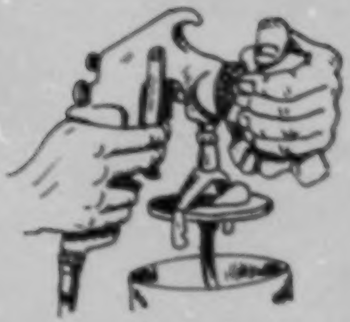
FIGURE 1



1. Hold shop cloth over air cap forcing thinner back to cup (Figure 2)

   (CAUTION: Keep vent covered to prevent blow out of thinner.)

FIGURE 2



2. Release cloth allowing thinner to flow through gun

3. Repeat steps 1 and 2 several times

D. Remove cup from gun

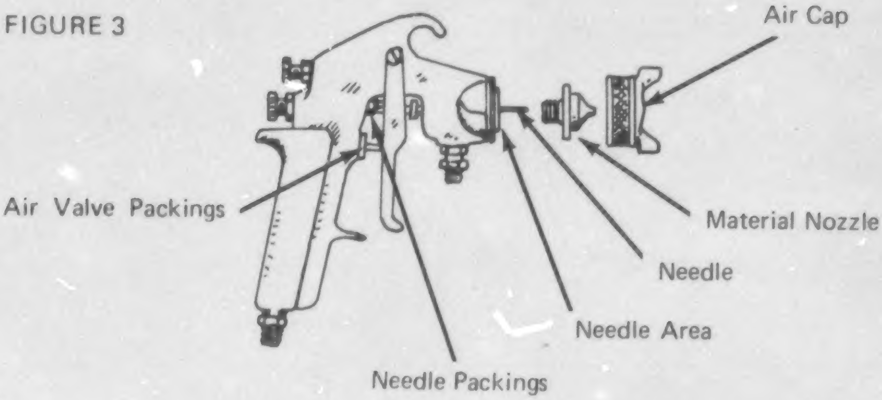
1. Pour out thinner

JOB SHEET #1

2. Pour clean lacquer thinner in cup

E. Remove air cap and material nozzle (Figure 3)

FIGURE 3


Air Cap
Air Valve Packings
Material Nozzle
Needle
Needle Area
Needle Packings

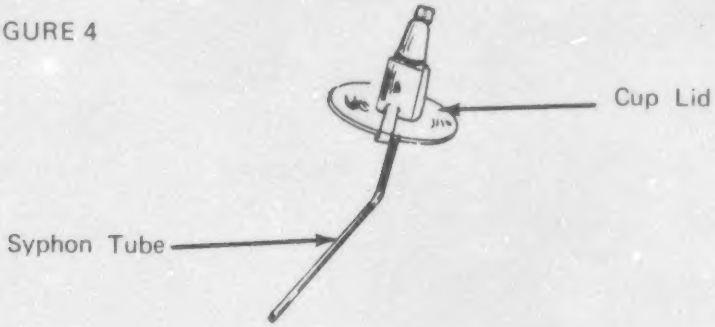
1. Put air cap in paint cup

2. Put material nozzle in paint cup

F. Wash needle area with gun brush and thinner (See Figure 3.)

G. Clean syphon tube with thinner and brush (Figure 4)

FIGURE 4


Cup Lid
Syphon Tube

H. Wash gun with thinner and dry with clean cloth

I. Lubricate packings (See Figure 3.)

1. Needle

JOB SHEET #1

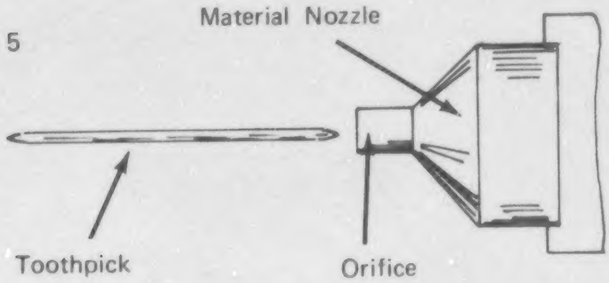
2. Air valve

   (NOTE: Lubricate exposed part of the needle and valve plunger.)

J. Remove material nozzle from cup (Figure 5)

   1. Clean inside with a gun brush
   2. Clean orifice with a toothpick

FIGURE 5

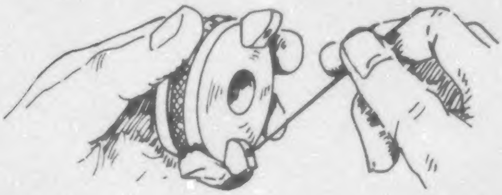


   3. Rinse and clean exterior
   4. Install on gun body

K. Remove air cap from paint cup

   1. Clean inside with gun brush
   2. Clean orifices with wood toothpick (Figure 6)

FIGURE 6



JOB SHEET #1

3. Rinse and clean exterior
4. Install on gun body

L. Pour contaminated paint thinner out of cup

M. Pour clean thinner into cup and install on gun

N. Spray thinner through gun

(NOTE: Force thinner back and forth as in step C.)

O. Pour out thinner and put gun in its proper storage place

(NOTE: If gun is not clean or is malfunctioning, check with your instructor. Do not try to correct any malfunction unless instructed to do so.)

(CAUTION: Thinners are highly flammable. Take all precautions to prevent bodily harm when using thinner to paint or to clean.)

REFINISHING EQUIPMENT
UNIT IV

JOB SHEET #2--CLEAN A PRESSURE POT

I. Tools, equipment, and materials needed

   A. Pressure pot paint system

   B. Gun wrench

   C. Air hose

   D. Air regulator

   E. Air compressor

   F. Air connectors

   G. Clean shop clothes

   H. Lacquer thinner or gun cleaner

   I. Round wood toothpicks

   J. Gun brushes

II. Procedure

   A. Shut off air to pot

   B. Release air release valve on pot

   C. Remove pot lid

   D. Pour out mixed paint from pot

   (NOTE: Do not pour mixed materials with unmixed materials.)

   E. Clean pot and lid with lacquer thinner

   (NOTE: It is advisable to remove all paint possible from the pot to help keep lacquer thinner or gun cleaning solvent clean.)

   F. Pour lacquer thinner into pot

      1. Install lid

      2. Pressurize the system

JOB SHEET #2

G. Spray thinner through gun

H. Release pressure and force thinner back to pot

(NOTE: Do this until all paint has been removed from gun and hose. Wash pot and put clean thinner in until hose and gun spray clean thinner.)

I. Release pressure and remove thinner

1. Clean pot
2. Clean lid
    a. Clean hose outlet on cover
    b. Clean air inlet on cover
3. Check material hose and repeat cleaning operation if not clean

J. Put lid back on pot and secure

K. Put pressure pot in its proper storage place

L. Clean paint gun (Job Sheet #1--Cleaning a Paint Gun)

(CAUTION: Thinners are highly flammable. Take all precautions to prevent bodily harm when using thinner to paint or to clean.)

REFINISHING EQUIPMENT
UNIT IV

JOB SHEET #3--CLEAN AN AIRLESS SPRAY SYSTEM

I. Tools, equipment, and materials needed

- A. Airless system
- B. Gun wrench
- C. Clean shop clothes
- D. Lacquer thinner or gun cleaner
- E. Round wood toothpick
- F. Gun brushes

II. Procedure

- A. Remove paint container from system and pour out contents
  1. Clean paint container
  2. Clean fluid outlet pipe
  3. Clean paint container cover
- B. Pour lacquer thinner into container and install on system
  1. Spray material through pump until all traces of paint are gone from stream being sprayed

     (CAUTION: Do not try to force material back to container. This is material under hydraulic pressure and will pierce the skin causing injury or death.)
  2. Back flush the system if back flush valve is available
- C. Clean container and lid
- D. Remove and clean paint gun (Job Sheet #1--Clean a Paint Gun)
- E. Lubricate proper lubrication points

  (NOTE: See manufacturer's recommendations.)
- F. Put system in proper storage place

REFINISHING EQUIPMENT
UNIT IV

JOB SHEET #4--DRAIN AN AIR REGULATOR (TRANSFORMER)

I. Tools and equipment needed

   A. Air regulator

   B. Air compressor

II. Procedure

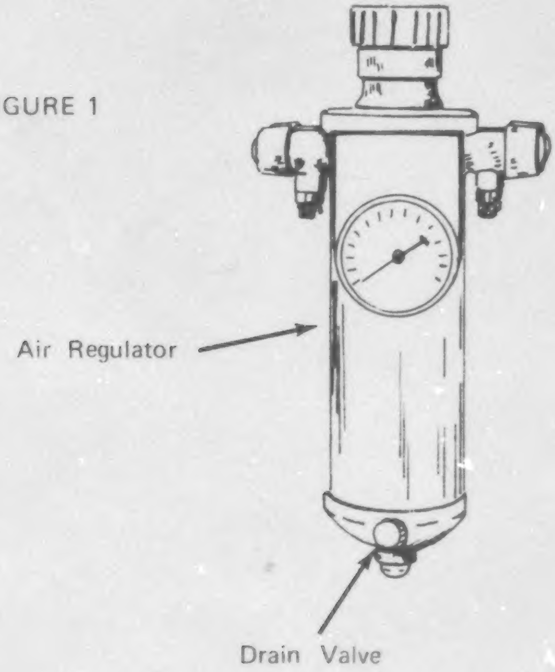
   A. Locate the air regulator drain valve

   B. Release the valve

   (NOTE: Water will run out of valve under air pressure. Allow to do so until air becomes dry. In systems where large volumes of air are used, draining of the regulator should be done several times a day. The air regulator should be drained every morning.) (Figure 1)

   (CAUTION: System is under high air pressure. Do not get foreign matter in eyes or on skin.)

FIGURE 1



REFINISHING EQUIPMENT
UNIT IV

JOB SHEET #5--DRAIN AND SERVICE AN AIR COMPRESSOR

I. Tools, equipment, and materials needed

A. Air compressor

B. Oil

II. Procedure

A. Turn off electric power to compressor

B. Drain air from compressor

(NOTE: Leave air valve open nearest compressor.)

C. Locate water drain and open

(NOTE: If system has a high side drain valve with an internal syphon tube, air pressure will have to remain in the tank to make it drain. If valve is in the bottom, let all air pressure out of the tank to prevent air locks which will not allow the tank to drain properly.)

D. Locate air intake filter

1. Dry filter

(NOTE: If dirty, replace.)

2. Oil bath--Clean filter and refill with oil

(NOTE: Use recommended weight to prevent the oil from being sucked into the compressor.)

E. Locate pump crankcase oil drain plug and remove

1. Drain oil into drain pan

2. Install plug and tighten

(NOTE: Always tighten a drain plug at the time you install it.)

3. Fill compressor crankcase

(NOTE: Follow the directions provided by the manufacturer as to type oil, weight, and amount.)

JOB SHEET #5

F. Check belts

1. If worn, replace

   (NOTE: Belts come in matched sets requiring the replacement of all belts.)

2. If loose, tighten

   (NOTE: Tighten belts to manufacturer's specifications to prevent damage to compressor and motor bearings.)

G. Close all valves and check all drain plugs

1. Air
2. Water drain plug
3. Oil drain plug

H. Start compressor--Turn on electric power

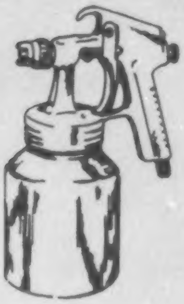
(NOTE: Water should be drained from the compressor daily.)

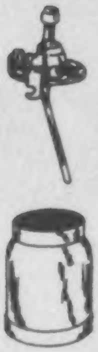
(CAUTION: Always turn off electric power when servicing the compressor. Bodily harm could result from being pulled into pulleys and belts.)

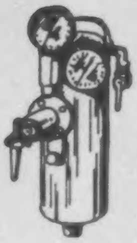
REFINISHING EQUIPMENT
UNIT IV

TEST

1. Identify refinishing equipment.



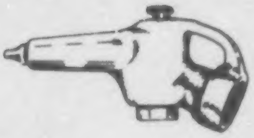


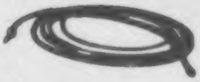


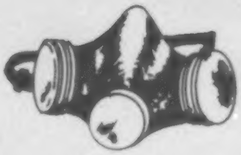
c. ____________________

a. ____________________

b. ____________________



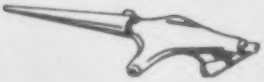




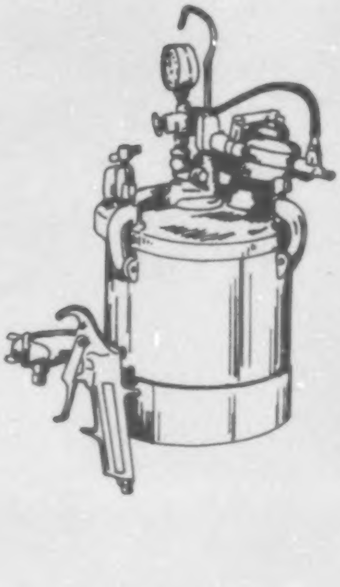
d. ____________________

e. ____________________

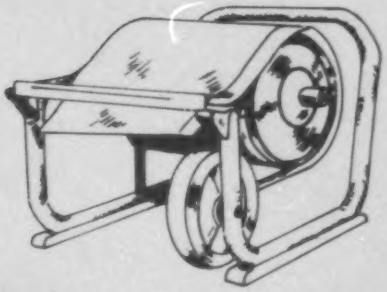
f. ____________________



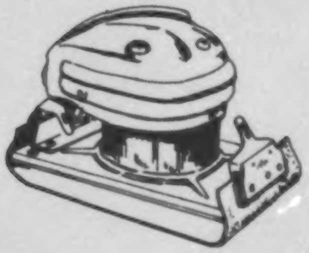
g. ____________________



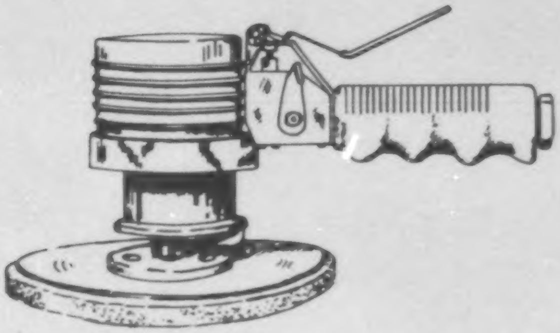
h. ____________________

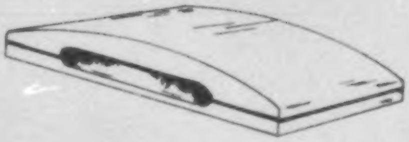


i. ______________________



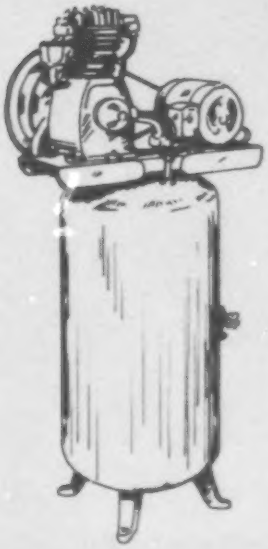
j. ______________________





l. ______________________

k. ______________________



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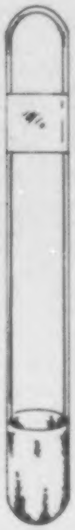
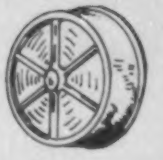
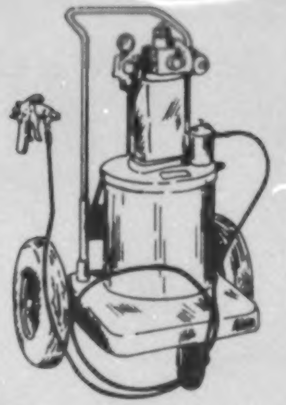


n. ______________________



o. ______________________



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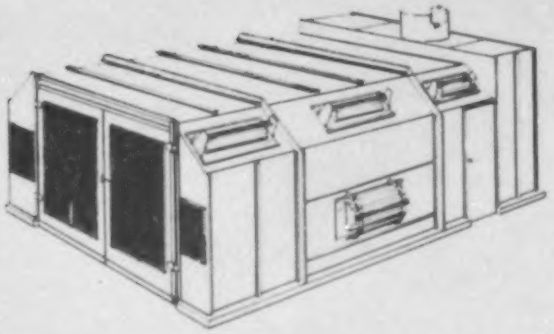
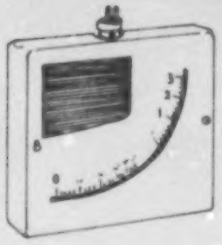
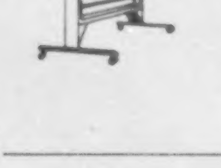


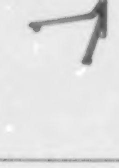
q. ______________________



r. ______________________



s. ______________________



t. ______________________

2. Complete six general safety rules concerning paint equipment.

   a. Always wear ____________ (____________) when spraying.

   b. Do not use compressed air to dry skin or remove dust from your ____________ or ____________.

   c. Wear appropriate ____________ for the job.

   d. Use paint equipment only for its ____________ use.

   e. Do not place ____________ over the outlet (nozzles) of any ____________ equipment when spraying.

   f. Do not make ____________ or ____________ equipment unless all electric power has been turned off.

3. Demonstrate the ability to:

   a. Clean a paint gun.

   b. Clean a pressure pot.

   c. Clean an airless spray system.

   d. Drain an air regulator (transformer).

   e. Drain and service an air compressor.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

REFINISHING EQUIPMENT
UNIT IV

ANSWERS TO TEST

1. a. Paint gun
   b. Paint cup, lid, and syphon tube
   c. Air regulator with water trap
   d. Blow gun
   e. Air hose
   f. Paint mask
   g. Air brush
   h. Pressure pot
   i. Apron taper
   j. Orbital sander
   k. Oscillating sander
   l. Sanding block
   m. Air compressor
   n. Viscosity cup
   o. Air dryer
   p. Airless spray system
   q. Paint booth
   r. Draft gauge
   s. Panel drying system
   t. Spot repair drying system
2. a. Masks (respirators)
   b. Skin, clothes
   c. Clothing

   d. Intended

   e. Hand, spray

   f. Repairs, service

3. Performance skills shall be evaluated according to the criteria listed on the progress chart.

Auto Body
PROGRESS CHART

Section D-1
Tools

276

	Unit I						Unit II						Unit III							
	General Hand Tools						Body Hand Tools						Power Tools & Equipment							
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	7	8
Job	Unit Test	Grind a Straight Blade Screwdriver	Dress a Flat Chisel & a Punch	Sharpen a Drill	Use all Hand Tools Safely & Correctly		Unit Test	Recondition a Finishing Hammer	Recondition a Dolly Block	Recondition a Body Spoon	Use all Body Tools Safely & Correctly		Unit Test	Portable Power Sanders or Polishers	Hydraulic Jack Equipment	Portable Drills	Pneumatic Air Hammers	Heat Gun	Bench Grinder	Drill Press
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
85% Correct																		
To Satisfaction of Instructor																		
To Satisfaction of Instructor																		
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100% Correct																		

Auto Body
PROGRESS CHART

Section D-2
Tools (continued)

	Unit III Power Tools & Equipment (Continued)							Unit IV Refinishing Equipment												
	9	10	11	12	13	14	15	1	2	3	4	5	6	7						
Job	Arc Welder	Service Jack	Front End Lift	Safety Stand	Frame Equipment	Use all Power Tools Safely & Correctly		Unit Test	Clean a Paint Gun	Clean a Pressure Pot	Clean an Airless Spray System	Drain an Air Regulator	Drain & Service an Air Compressor							
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy

	100% Correct	100% Correct	100% Correct	100% Correct	100% Correct	To Satisfaction of Instructor		100% Correct	100% Correct	100% Correct	100% Correct	100% Correct	100% Correct							
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OXYACETYLENE FUSION WELDING
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to properly set up, light, adjust, and turn off oxyacetylene welding equipment following the proper order and safety precautions. In addition, he should be able to select the proper size welding tip according to manufacturer's recommendations and to choose the correct filler rod for a welding job. He should be able to demonstrate the ability to carry a puddle with or without a filler rod. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match six terms associated with oxyacetylene fusion welding to the correct definition.
2. List ten safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.
3. Identify oxyacetylene welding equipment.
4. Name five factors that determine fusion weld quality.
5. List five properties of a good weld.
6. Name two factors that determine tip size in oxyacetylene fusion welding.
7. List two factors that determine the type of filler rod to use in oxyacetylene fusion welding.
8. Describe the purpose of the filler rod.
9. Identify three types of oxyacetylene fusion welding flames.
10. Demonstrate the ability to:
    a. Set up equipment for oxyacetylene welding.
    b. Turn on, light, adjust, and turn off the oxyacetylene welding equipment.
    c. Construct a corner weld without filler rod.
    d. Lay beads on gauge metal with and without filler rod.
    e. Weld butt joints with filler rod.

OXYACETYLENE FUSION WELDING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in the job sheets.
- G. Give test.

(NOTE: The instructor may want to secure film from the Curriculum and Instructional Materials Center on Fusion Welding to show to the class.)

II. Students:

- A. Read objectives.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency masters
    1. TM 1--Oxyacetylene Welding Equipment
    2. TM 2--Welding Torches
    3. TM 3--Welding Regulators
    4. TM 4--Oxyacetylene Fusion Welding Flames

D. Job sheets

1. Job Sheet #1--Set Up Equipment for Oxyacetylene Welding
2. Job Sheet #2--Turn On, Light, Adjust, and Turn Off Oxyacetylene Welding Equipment
3. Job Sheet #3--Construct a Corner Weld Without a Filler Rod
4. Job Sheet #4--Lay Beads On Light Gauge Metal Without Filler Rod
5. Job Sheet #5--Lay Beads On Light Gauge Metal With Filler Rod
6. Job Sheet #6--Weld Butt Joints With Filler Rod

E. Test

F. Answers to test

II. References:

A. *Smith's Instructor's Manual for a Basic Course in Oxyacetylene Brazing, Cutting, and Welding (Form 424).* Minneapolis, Minnesota: Smith Welding Equipment, Division of Tescom Corporation.

B. *Instructor's Answer Key (Form 429).* For use with *Smith's Instructor's Manual (Form 424).* Minneapolis, Minnesota: Smith Welding Equipment, Division of Tescom Corporation.

C. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. *Farm Mechanics Text and Handbook.* Danville, Illinois: The Interstate Printers and Publishers, Inc.

D. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. *Modern Welding.* Homewood, Illinois: Goodheart-Willcox Company, Inc.

E. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures.* New York: Union Carbide Corporation, Linde Division.

OXYACETYLENE FUSION WELDING
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Fusion welding--Joining pieces of metal by heating the adjoining edges to the fusion or melting point and allowing them to flow or run together and then cool

   B. Penetration--Distance from the original surface of the base metal to that point at which fusion ceases

   C. Base metal--Metal being welded

   D. Alloy--Mixture with metallic properties composed of two or more elements of which one is a metal

   E. Inner cone--Inner white part of the neutral flame

   F. Tack weld--Short weld used for temporarily holding material in place

II. Safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment

   A. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over

      (NOTE: Acetylene gas is in a liquid state in the cylinder and should be used in a vertical position so that acetone will not be withdrawn.)

   B. Blow out cylinder valves (crack cylinder valve for a second before attaching regulators) in order to remove dust and dirt that may damage regulator

   C. Release pressure adjusting screw on regulator before opening cylinder valve in order to prevent damage to regulators and possible injury to operator

   D. Stand to the side of regulators keeping the cylinder valve between operator and regulator when opening cylinder valves

   E. Open cylinder valves slowly

   F. Do not use acetylene (in free state) at pressures higher than 15 psi

      (NOTE: Acetylene becomes unstable at pressures above 15 psi and becomes highly explosive.)

   G. Purge oxygen and acetylene passages (individually) before lighting torch

   H. Light acetylene before opening oxygen torch valve

INFORMATION SHEET

I. Never use oil or grease on regulators, torches, or fittings

(NOTE: Oil or grease and oxygen have a very great affinity for one another and will unite with explosive violence.)

J. Do not use oxygen as a substitute for compressed air

K. Use safety goggles, gloves, and protective clothing

L. Have CO_2 or dry powder type fire extinguisher available

M. Test connections for leaks with Ivory soapsuds, paintbrush, and water

N. Avoid lighting torch or cutting near combustible materials

O. Never open the acetylene cylinder valve more than 1/2-3/4 turns

P. Always operate torch in a well-ventilated area

Q. Never cut on containers that have been used for combustible materials

R. Avoid breathing toxic fumes when cutting

Example: Galvanized metal

S. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves

T. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on the equipment

U. Turn acetylene torch valve off first in order that the flame will go out immediately

V. Keep hands, gloves, and clothing free from oil and grease

W. Never cut or weld too close to concrete

X. Always weld or cut at least five feet from cylinder

Y. Always protect hoses from hot metal, rupture, or mechanical damage

Z. Always light torch with a friction lighter

AA. Never leave a burning torch unattended

III. Oxyacetylene welding equipment (Transparencies 1, 2, and 3)

A. Acetylene cylinder

INFORMATION SHEET

  - B. Acetylene cylinder valve
  - C. Acetylene fitting
  - D. Acetylene regulator
  - E. Oxygen cylinder
  - F. Oxygen cylinder valve
  - G. Oxygen fitting
  - H. Oxygen regulator
  - I. Oxygen torch valve
  - J. Welding torch body
  - K. Acetylene torch valve
  - L. Welding tip
  - M. Welding goggles with #5 shade lens
  - N. Welding gloves
  - O. Safety chain
  - P. Flint lighter
  - Q. Cylinder truck

IV. Factors determining fusion weld quality

  - A. Proper flame adjustment
  - B. Angle of tip
  - C. Distance from work
  - D. Speed of travel
  - E. Movement of tip

V. Properties of a good weld

  - A. Consistent width
  - B. Straightness
  - C. Slightly crowned
  - D. Fused into base metal
  - E. Clean appearance

INFORMATION SHEET

VI. Factors determining tip size selection

   A. Metal thickness

   B. Size of welding rod

   (NOTE: Always use manufacturer's recommendations on tip size.)

VII. Factors determining rod selection

   A. Rod with similar properties as base metal

   B. Thickness of metal

   (NOTE: A general rule is to use a rod with a diameter equal to the thickness of the base metal.)

VIII. Purpose of filler rod--To add strength to weld or joint

IX. Oxyacetylene fusion welding flames (Transparency 4)

   A. Carburizing flame

      1. Contains excess of acetylene

      (NOTE: An acetylene feather is visible on the inner cone.)

      2. Recommended flame for cutting cast iron

      3. Introduces carbon into weld, causing hardening of the metal

      (NOTE: The resultant weld is weak.)

   B. Neutral flame

      1. Burns equal amounts of oxygen and acetylene

      2. Identified by clear, well-defined white cone

      3. Temperature 5950°

   C. Oxidizing flame

      1. Burns excess of oxygen

      2. Identified by short white inner cone

      3. Oxidizes the metal causing it to harden and become brittle

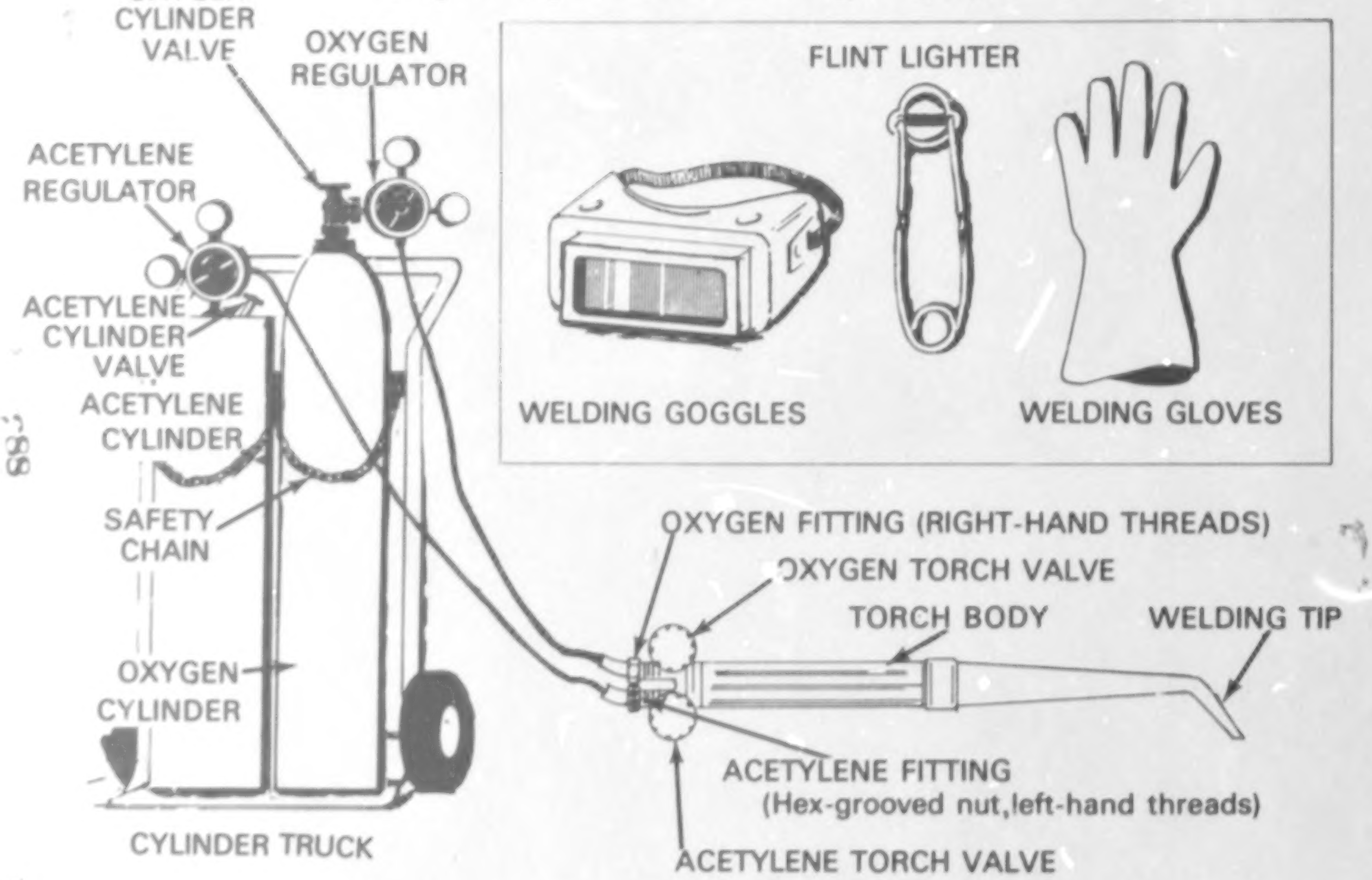
      4. Not recommended for average cutting

INFORMATION SHEET

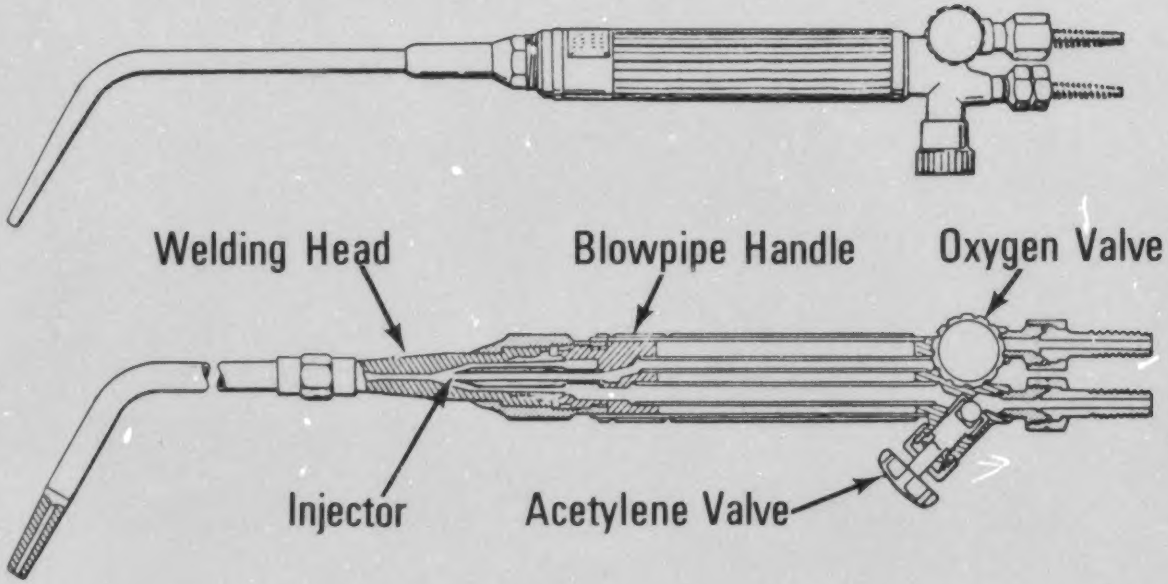
5. Is the hottest flame

6. A slightly oxidizing flame is recommended for brazing

Oxyacetylene Welding Equipment

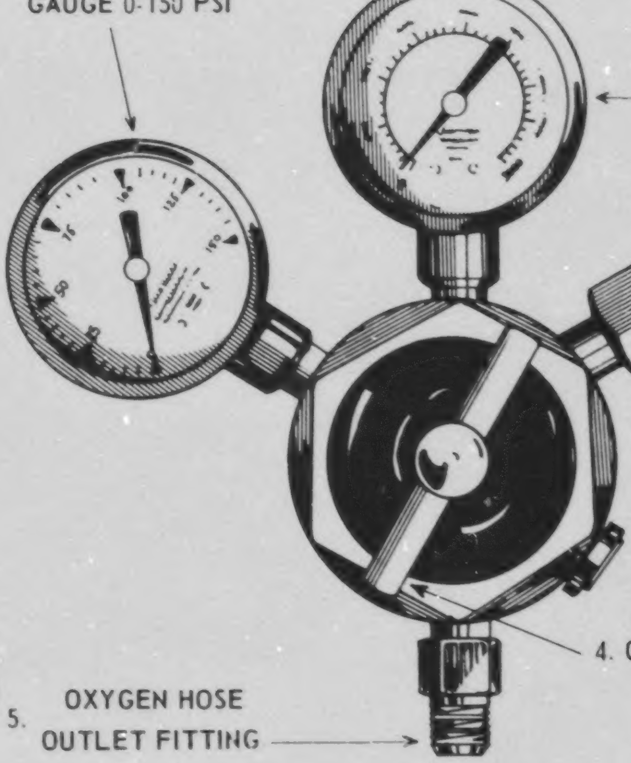

OXYGEN CYLINDER VALVE
OXYGEN REGULATOR
ACETYLENE REGULATOR
ACETYLENE CYLINDER VALVE
ACETYLENE CYLINDER
SAFETY CHAIN
OXYGEN CYLINDER
CYLINDER TRUCK
FLINT LIGHTER
WELDING GOGGLES
WELDING GLOVES
OXYGEN FITTING (RIGHT-HAND THREADS)
OXYGEN TORCH VALVE
TORCH BODY
WELDING TIP
ACETYLENE FITTING
(Hex-grooved nut,left-hand threads)
ACETYLENE TORCH VALVE

Welding Torches

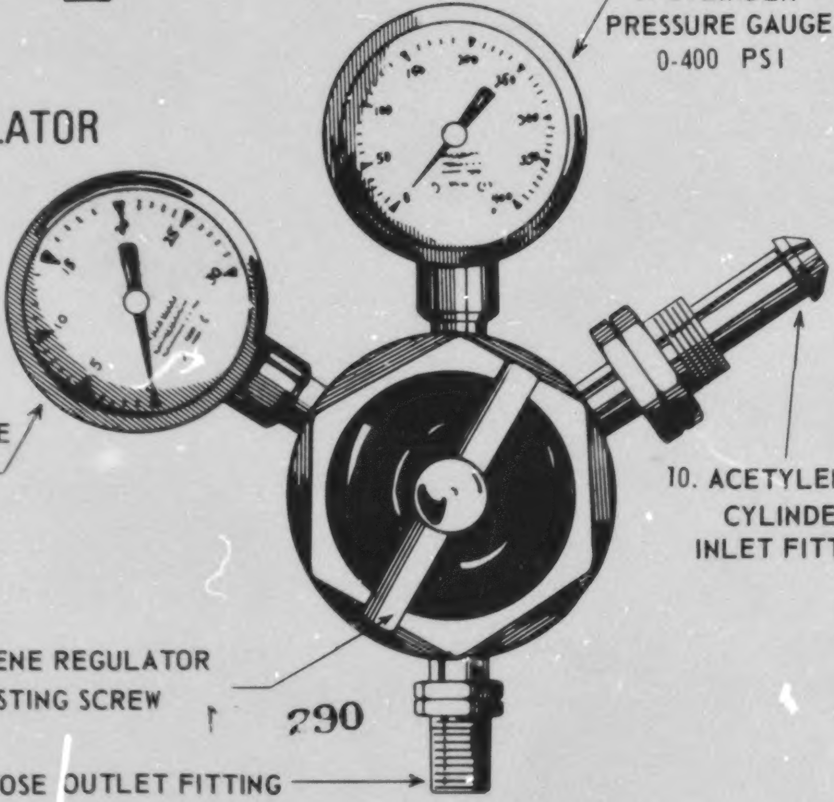

Welding Head
Blowpipe Handle
Oxygen Valve
Injector
Acetylene Valve

Welding Regulators

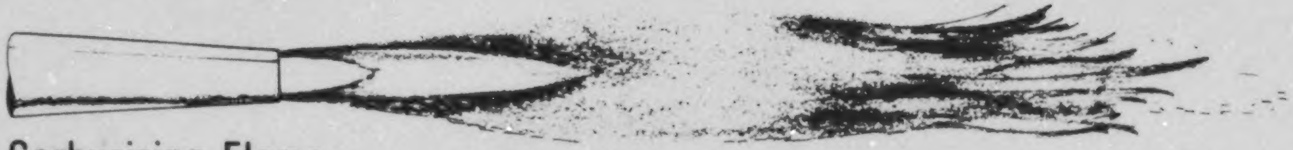
A. OXYGEN REGULATOR GAUGES


1. WORKING PRESSURE GAUGE 0-150 PSI
2. CYLINDER PRESSURE GAUGE 0 to 3000 PSI
3. OXYGEN CYLINDER INLET FITTING
4. OXYGEN REGULATOR ADJUSTING SCREW
5. OXYGEN HOSE OUTLET FITTING

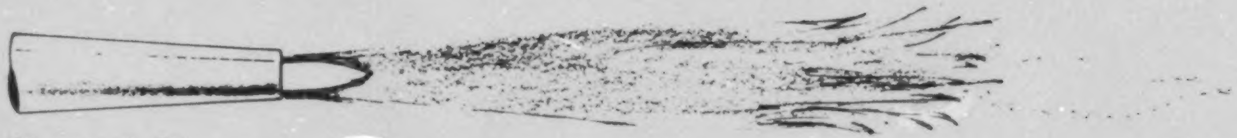
B. ACETYLENE REGULATOR


6. CYLINDER PRESSURE GAUGE 0-400 PSI
7. WORKING PRESSURE GAUGE 0 TO 30 PSI
8. ACETYLENE REGULATOR ADJUSTING SCREW
9. ACETYLENE HOSE OUTLET FITTING
10. ACETYLENE CYLINDER INLET FITTING

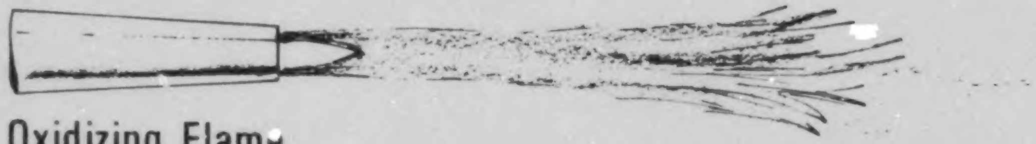
Oxyacetylene Fusion Welding Flames



Carburizing Flame



Neutral Flame



Oxidizing Flame

OXYACETYLENE FUSION WELDING
UNIT I

JOB SHEET #1--SET UP EQUIPMENT FOR OXYACETYLENE WELDING

I. Procedure for setting up equipment

A. Fasten cylinders in a vertical position

B. Remove caps from cylinders

C. Crack valves of each cylinder then close valves

D. Connect oxygen regulator to oxygen cylinder

1. Turn pressure adjusting screw on regulator counterclockwise until tension on spring is released

2. Slowly open cylinder and tighten in open position

E. Connect acetylene regulator to acetylene cylinder

1. Turn pressure adjusting screw on regulator counterclockwise until tension on spring is released

2. Open cylinder valve 1/2 to 3/4 of a turn (never more than 1 1/2 turns)

F. Connect acetylene hose (red) to acetylene regulator and purge hose

(NOTE: All acetylene fittings have a grooved nut to indicate left-hand threads.)

G. Connect oxygen hose (green) to oxygen regulator and purge hose

(NOTE: All oxygen fittings have right-hand threads.)

H. Connect torch body to oxygen and acetylene hose and close both valves on torch body

I. Attach welding tip to torch body

(NOTE: Size of tip is determined by thickness of metal to be welded. Use manufacturer's recommendations for tip size and working pressures.)

J. Turn pressure adjusting screw on oxygen regulator clockwise until working pressure is reached

K. Turn pressure adjusting screw on acetylene regulator clockwise until working pressure is reached

L. Test all connections for leaks with Ivory soapsuds and water

(NOTE: Apply soapsuds with a clean paintbrush.)

OXYACETYLENE FUSION WELDING
UNIT I

JOB SHEET #2--TURN ON, LIGHT, ADJUST, AND TURN OFF OXYACETYLENE WELDING EQUIPMENT

I. Procedure for turning on and lighting

A. Check all cylinder, regulator, and torch valves to make sure they are turned off

B. Open acetylene cylinder valve 1/2 to 3/4 of a turn

(CAUTION: Never open more than 1 1/2 turns.)

C. To purge line, open acetylene valve on torch one turn

*D. Turn acetylene regulator pressure adjusting screw clockwise until desired working pressure is reached

E. Close acetylene valve on torch

F. Open oxygen cylinder valve all the way and tighten in open position

G. Open oxygen torch valve one turn

*H. Turn oxygen regulator pressure adjusting screw clockwise until desired pressure is reached

I. Close oxygen valve on torch

J. Open acetylene valve on torch 1/4 turn

K. Light the torch with flint lighter and adjust until smoke on flame clears

L. Open oxygen torch valve and adjust to a neutral flame with a tiny trace of feather on the inner cone

(*NOTE: The working pressure is determined by the size of the tip.)

II. Procedure for adjusting welding torch for the three types of flames

A. Start with a neutral flame

B. To produce a carburizing flame, reduce the supply of oxygen by slowly closing the oxygen torch valve until an excess acetylene feather is produced

C. To produce an oxidizing flame, increase the supply of oxygen by slowly opening the oxygen torch valve until a short, white inner cone is produced

JOB SHEET #2

III. Procedure for turning off the torch and oxyacetylene welding unit

A. Close acetylene torch valve

B. Close oxygen torch valve

C. Close acetylene cylinder valve

D. Close oxygen cylinder valve

E. Open acetylene torch valve

(NOTE: When gauges reach 0, release acetylene regulator pressure adjusting screw and close torch valve.)

F. Open oxygen valve on torch

(NOTE: When gauges reach 0, release oxygen regulator pressure adjusting screw and close torch valve.)

G. Place torch and hoses on hanger or brackets

OXYACETYLENE FUSION WELDING
UNIT I

JOB SHEET #3--CONSTRUCT A CORNER WELD WITHOUT A FILLER ROD

I. Tools, materials, and equipment needed

   A. Oxyacetylene welding unit

   B. Welding tip (according to manufacturer's recommendations)

   C. Gloves

   D. Goggles

   E. Pliers

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Two pieces of mild steel strips, 1 1/4" by 6"

II. Procedure

   A. Prepare metal for welding

   B. Place metal in welding position

   C. Turn on oxyacetylene unit

   D. Set working pressure (according to manufacturer's recommendations)

   E. Light torch and adjust to a neutral flame with very slight feather

   F. Tack weld metal in position

   G. Place inner cone about 1/16" to 1/8" from plate

   H. Do not begin travel until you have established a molten puddle

   I. Begin welding at right end

   J. Hold tip vertically at 45° angle from direction of travel

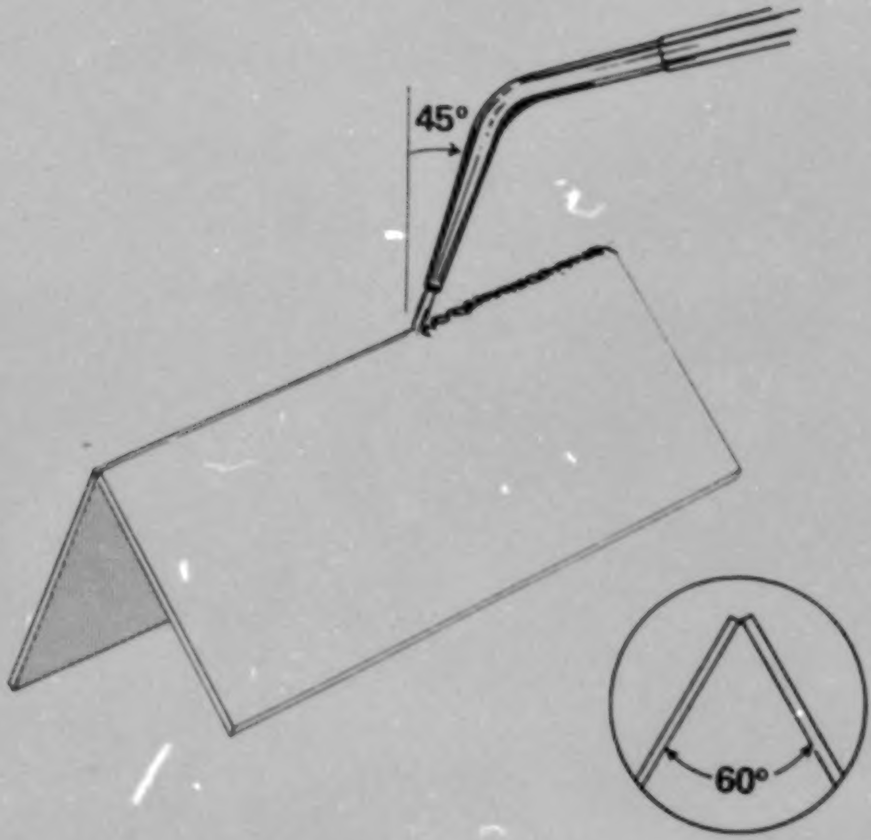
   K. Slowly move flame down the joint forming puddle as you travel from right to left

   L. Examine welded joint for good bead characteristics and penetration

   M. Repeat process until instructor gives permission to go on to next job

JOB SHEET #3

III. Diagram of the procedure



OXYACETYLENE FUSION WELDING
UNIT I

JOB SHEET #4--LAY BEADS ON LIGHT GAUGE METAL WITHOUT FILLER ROD

I. Tools, materials, and equipment needed

   A. Oxyacetylene welding unit

   B. Welding tip (according to manufacturer's recommendations)

   C. Gloves

   D. Goggles

   E. Pliers

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. One piece of mild steel, 1 1/4" x 6"

II. Procedure

   A. Prepare metal for welding

   B. Place metal in welding position

   C. Turn on oxyacetylene unit

   D. Set working pressure (according to manufacturer's recommendations)

   E. Light torch and adjust to a neutral flame

   F. Place inner cone about 1/16" to 1/8" from metal

   G. Do not begin travel until you have established a molten puddle

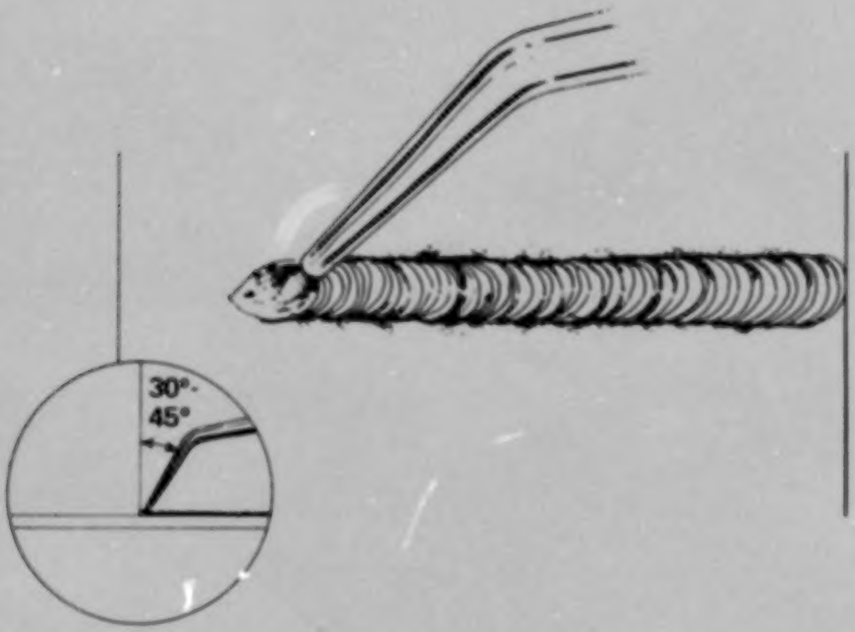
   H. Hold torch 30° to 45° from center in direction of travel

   I. Slowly move the torch forward allowing the metal to melt

   J. Repeat process until instructor gives permission to go on to next job

JOB SHEET #4

III. Diagram of the procedure



OXYACETYLENE FUSION WELDING
UNIT I

JOB SHEET #5–LAY BEADS ON LIGHT GAUGE METAL WITH FILLER ROD

I. Tools, materials, and equipment needed

   A. Oxyacetylene welding unit

   B. Welding tip (according to manufacturer's recommendations)

   C. Gloves

   D. Goggles

   E. Pliers

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. One piece of mild steel strip, 1 1/4" by 6"

   J. Filler rod mild steel (according to manufacturer's recommendations)

II. Procedure

   A. Prepare metal for welding

   B. Place metal in welding position

   C. Turn on oxyacetylene unit

   D. Set working pressure (according to manufacturer's recommendations)

   E. Light torch and adjust to a neutral flame

   F Hold torch 30° to 45° from center

   G. Place inner cone about 1/16" to 1/8" from surface of puddle

   H. Do not begin travel until you have established a molten puddle

   I. Add filler rod to front edge of puddle in front of torch

   J. Move puddle forward with torch and allow puddle to form in base metal

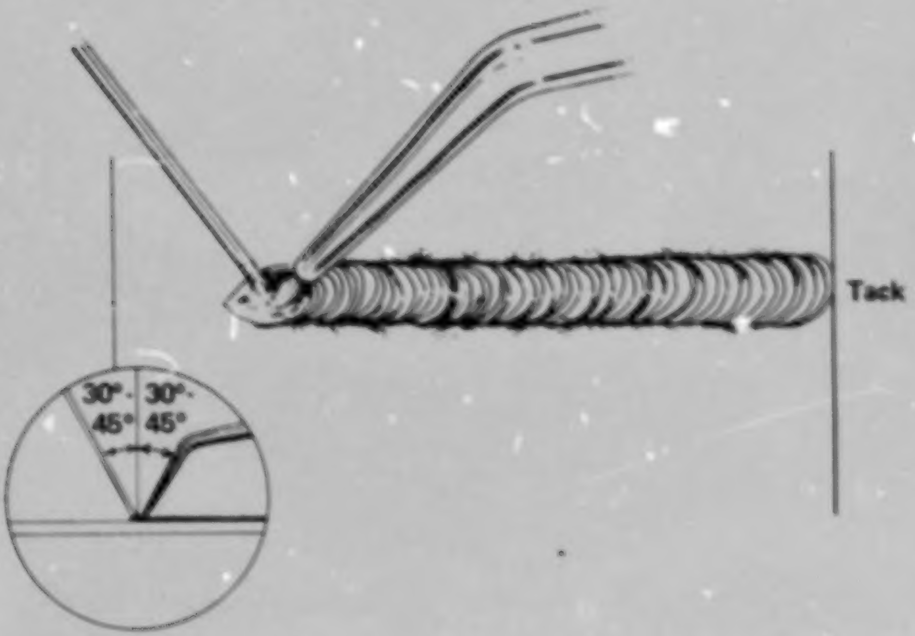
   K. Add rod and withdraw rod to front edge of puddle as you move puddle forward

JOB SHEET #5

L. Keep puddle the same size and shape the entire length of the bead

M. Show bead to instructor when completed

III. Diagram of the procedure



OXYACETYLENE FUSION WELDING
UNIT I

JOB SHEET #6--WELD BUTT JOINTS WITH FILLER ROD

I. Tools, materials, and equipment needed

  A. Oxyacetylene welding unit

  B. Welding tip (according to manufacturer's recommendations)

  C. Gloves

  D. Goggles

  E. Pliers

  F. Wire brush

  G. Flint lighter

  H. Fire brick

  I. Two pieces of mild steel strips, 1 1/4" by 6"

  J. Filler rod mild steel (according to manufacturer's recommendations)

II. Procedure

  A. Prepare metal for welding

  B. Place metal in welding position

  C. Turn on oxyacetylene unit

  D. Set working pressure (according to manufacturer's recommendations)

  E. Light torch and adjust to a neutral flame

  F. Tack weld metal together at both ends of joint

  G. Hold torch 30° to 45° from center

  H. Do not begin travel until you have established a molten puddle

  I. Place inner cone about 1/16" to 1/8" from surface of puddle

  J. Add filler rod to front edge of puddle in front of torch

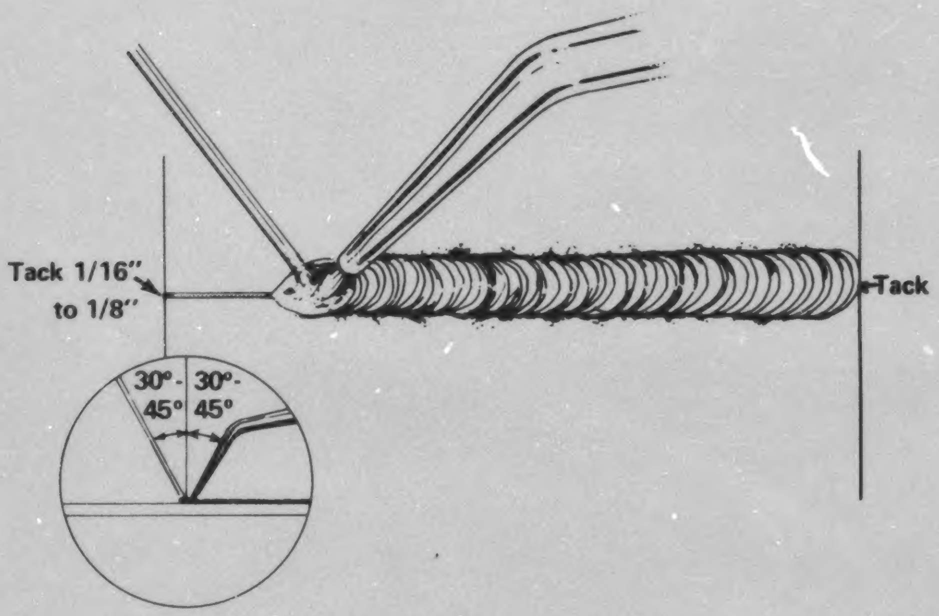
  K. Move puddle forward with torch and allow puddle to form in base metal

JOB SHEET #6

L. Add rod and withdraw rod to front edge of puddle as you move puddle forward

M. Keep puddle the same size and shape the entire length of the bead

III. Diagram of the procedure


Tack 1/16" to 1/8"
Tack
30°-45°
30°-45°

OXYACETYLENE FUSION WELDING
UNIT I

TEST

1. Match the terms on the right to the correct definition.

_____a. Short weld used for temporarily holding material in place

_____b. Joining pieces of metal by heating the adjoining edges to the fusion or melting point and allowing them to flow or run together and then cool

_____c. Metal being welded

_____d. Distance from the original surface of the base metal to that point at which fusion ceases

_____e. Mixture with metallic properties composed of two or more elements of which one is a metal

_____f. Inner white part of the neutral flame

1. Base metal
2. Alloy
3. Tack weld
4. Inner cone
5. Fusion welding
6. Penetration

2. List ten safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.

a.

b.

c.

d.

e.

f.

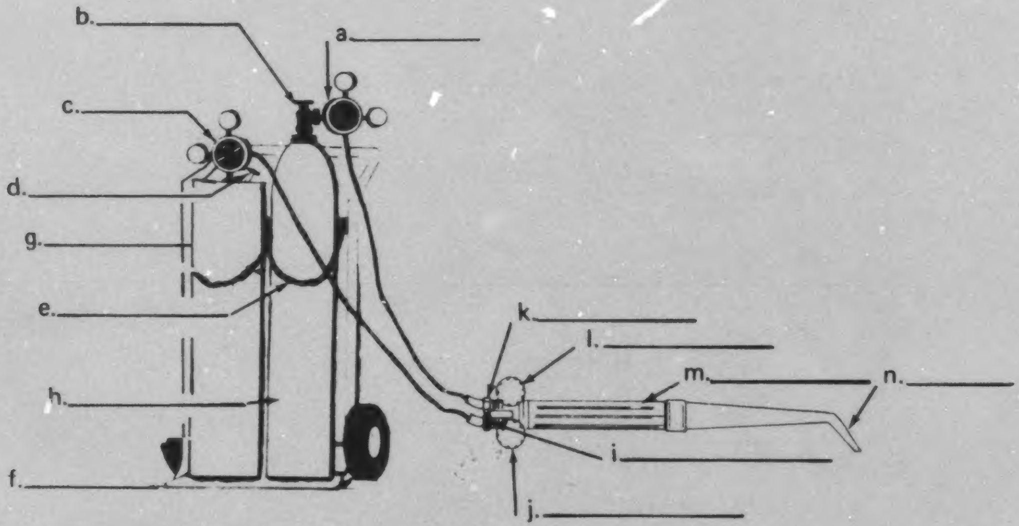
g.

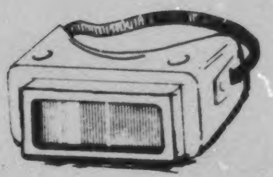
h.

i.

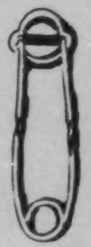
j.

3. Identify the following oxyacetylene fusion welding equipment.

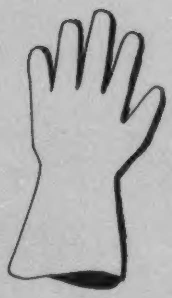

b. ____
a. ____
c. ____
d. ____
g. ____
e. ____
k. ____
l. ____
m. ____
n. ____
h. ____
i. ____
f. ____
j. ____



o. ____



p. ____



q. ____

4. Name five factors that determine fusion weld quality.

   a.

   b.

   c.

   d.

   e.

5. List five properties of a good weld.

   a.

   b.

   c.

   d.

   e.

6. Name two factors that determine tip size in oxyacetylene fusion welding.

   a.

   b.

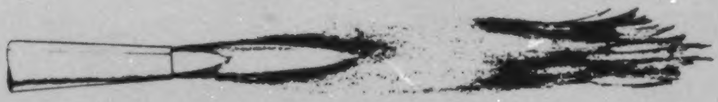
7. List two factors that determine the type of filler rod to use in oxyacetylene fusion welding.

   a.

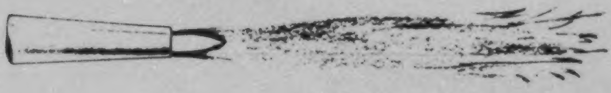
   b.

8. Describe the purpose of the filler rod.

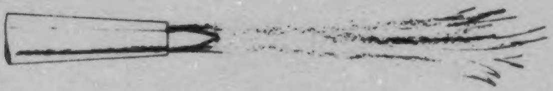
9. Identify three types of oxyacetylene fusion welding flames.



a.______________________________________



b.______________________________________



c.______________________________________

10. Demonstrate the ability to:

a. Set up equipment for oxyacetylene welding.

b. Turn on, light, adjust, and turn off the oxyacetylene welding equipment.

c. Construct a corner weld without filler rod.

d. Lay beads on gauge metal with and without filler rod.

e. Weld butt joints with filler rod.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

OXYACETYLENE FUSION WELDING
UNIT I

ANSWERS TO TEST

1. a. 3

   b. 5

   c. 1

   d. 6

   e. 2

   f. 4

2. Any ten of the following

   a. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over

   b. Blow out cylinder valves (crack cylinder valve for a second before attaching regulators) in order to remove dust and dirt that may damage regulator

   c. Release pressure adjusting screw on regulator before opening cylinder valve in order to prevent damage to regulators and possible injury to operator

   d. Stand to the side of regulators keeping the cylinder valve between operator and regulator when opening cylinder valves

   e. Open cylinder valves slowly

   f. Do not use acetylene (in free state) at pressures higher than 15 psi

   g. Purge oxygen and acetylene passages (individually) before lighting torch

   h. Light acetylene before opening oxygen torch valve

   i. Never use oil or grease on regulators, torches, or fittings

   j. Do not use oxygen as a substitute for compressed air

   k. Use safety goggles, gloves, and protective clothing

   l. Have CO_2 or dry powder type fire extinguisher available

m. Test connections for leaks with Ivory soapsuds, paintbrush, and water

n. Avoid lighting torch or cutting near combustible materials

o. Never open the acetylene cylinder valve more than 1/2-3/4 turns

p. Always operate torch in a well-ventilated area

q. Never cut on containers that have been used for combustible materials

r. Avoid breathing toxic fumes when cutting

s. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves

t. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on the equipment

u. Turn acetylene torch valve off first in order that the flame will go out immediately

v. Keep hands, gloves, and clothing free from oil and grease

w. Never cut or weld too close to concrete

x. Always weld or cut at least five feet from cylinder

y. Always protect hoses from hot metal, rupture, or mechanical damage

z. Always light torch with a friction lighter

aa. Never leave a burning torch unattended

3. a. Oxygen regulator

b. Oxygen cylinder valve

c. Acetylene regulator

d. Acetylene cylinder valve

e. Safety chain

f. Cylinder truck

g. Acetylene cylinder

h. Oxygen cylinder

i. Acetylene fitting

j. Acetylene torch valve

k. Oxygen fitting

l. Oxygen torch valve

m. Welding torch body

n. Welding tip

o. Welding goggles with #5 shade lens

p. Flint lighter

q. Welding gloves

4. a. Proper flame adjustment

   b. Angle of tip

   c. Distance from work

   d. Speed of travel

   e. Movement of tip

5. a. Consistent width

   b. Straightness

   c. Slightly crowned

   d. Fused into base metal

   e. Clean appearance

6. a. Metal thickness

   b. Size of welding rod

7. a. Rod with similar properties as base metal

   b. Thickness of metal

8. To add strength to weld or joint

9. a. Carburizing

   b. Neutral

   c. Oxidizing

10. Performance skills will be evaluated according to the criteria listed on the progress chart.

OXYACETYLENE BRAZE WELDING
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to distinguish between braze and fusion welding and be able to list advantages and disadvantages of brazing. He should be able to demonstrate the procedures for applying flux to a filler rod and construct a butt weld using the brazing process. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match five terms associated with braze welding to the correct definition.
2. State the differences between brazing and braze welding procedures.
3. List three advantages of braze welding.
4. List three disadvantages of braze welding.
5. List four characteristics of the elements found in the filler rods used in braze welding.
6. State the importance of having a chemically clean metal surface in braze welding.
7. Name the procedures for removing oxides from a clean metal surface.
8. Name five purposes of flux.
9. Name the color of the base metal when the proper temperature is obtained in braze welding.
10. Describe the reaction of the molten bronze when the temperature of the base metal is too hot, too cold, or medium.
11. Demonstrate the ability to braze weld a square groove butt joint.

OXYACETYLENE BRAZE WELDING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparency.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedure outlined in the job sheet.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedure outlined in the job sheet.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency master: TM 1--Braze Welding a Butt Joint

  D. Job Sheet #1--Braze Weld a Square Groove Butt Joint

  E. Test

  F. Answers to test

II. References:

A. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures*. New York: Union Carbide Corporation, Linde Division, 1960.

B. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. *Modern Welding*. Homewood, Illinois: Goodheart-Willcox Co., 1965.

C. Giachino, J. W., William Weeks, and Elmer Brune. *Welding Skills and Practices*. Chicago, Illinois: American Technical Society, 1967.

OXYACETYLENE BRAZE WELDING
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Braze welding--Heating the base metal to a dull red color and depositing a bead over the seam (joint) with a bronze filler rod; the base metal is not melted (Transparency 1)

   B. Malleability--A property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness

   C. Ductile--A term describing metal which is capable of being drawn or stretched out

   D. Tinning operation--Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)

   (NOTE: It is this flow of a thin film of bronze which is known as tinning.)

   E. Flux--A chemical used to clean metals and to promote fusion during the welding process

II. Differences between brazing and braze welding procedures

   A. Brazing--A group of welding processes wherein coalescence (the forming together in one mass) is brought about by

      1. Having a joint which requires only a thin film of filler metal

      2. The distribution of filler metal between the closely fitted surfaces of the joint by capillary attraction

      (NOTE: Capillary attraction is the power of a heated surface to draw and spread molten metal.)

   B. Braze welding--Performed in the same manner as fusion welding except that the base metal is not melted

      1. The joint design is the same as used in fusion welding

      2. The welding technique used for braze welding is the same as in fusion welding except that the base metal is raised only to the "tinning" temperature

INFORMATION SHEET

(NOTE: The procedures for brazing and braze welding also share common characteristics. The nonferrous filler rod or alloy has a melting point higher than 800° F. but lower than that of the metals or alloys to be joined. Furthermore, although the base metal is never actually melted in braze welding, the bond between the bronze rod and the base metal is such that the results obtained are fully comparable to those obtained through fusion welding.)

III. Advantages of braze welding

- A. Less possibility of destroying main characteristics of base metal
  - 1. Base metal does not have to be heated to a molten condition
    - a. This increases the speed of joining metals
    - b. Less gas is consumed for a given job
  - 2. In repairing malleable castings, there is less danger of its losing its ductible properties
- B. The low degree of heat minimizes expansion and contraction forces
- C. Less need for extensive preheating

IV. Disadvantages of braze welding

- A. Not recommended for parts which are to be raised to temperatures higher than the melting point of bronze, either in service or during heat treatment
- B. Bronze will lose its strength at temperatures above 500° F.
- C. It cannot be used on metal where stress is a factor
- D. Bronze may have corrosion-resistant properties which differ from those of the base metal being used

V. Characteristics of the elements found in the filler rods used in braze welding

- A. Consist of copper alloys containing about 60 percent copper and 40 percent zinc which:
  - 1. Produce a high tensile strength
  - 2. Increase ductility
- B. Contain small quantities of tin, iron, manganese, and silicon which help to:
  - 1. Deoxidize the weld metal
  - 2. Decrease the tendency to fume

INFORMATION SHEET

3. Increase the free-flowing action of the molten metal

4. Increase the hardness of the deposited metal for greater wear resistance

VI. Importance of a chemically clean metal surface in bronze welding

A. To guarantee the molten bronze will stick to the base metal

B. To have a stronger bond on base metals

VII. Procedures for removing oxides

A. Mechanical means

1. Wire brush

2. Grinder

B. Chemical--Flux

(NOTE: Both methods should be employed to completely remove the oxides.)

VIII. Purposes of the flux

A. Chemically cleans the base metal

B. Prevents oxidation of the filler metal

C. Floats and removes the oxides already present

D. Increases the flow of the filler metal

E. Increases the ability of the filler metal to adhere to the base metal

F. Brings the filler metal into immediate contact with the metals being joined

G. Permits the filler metal to penetrate the pores of the base metal

IX. Color of base metal when the proper temperature is obtained--A dull red

(NOTE: Base metal will begin to glow.)

X. Reaction of molten bronze at different temperatures

A. If base metal is not hot enough, the molten bronze, rather than flowing over the surface, will form into drops

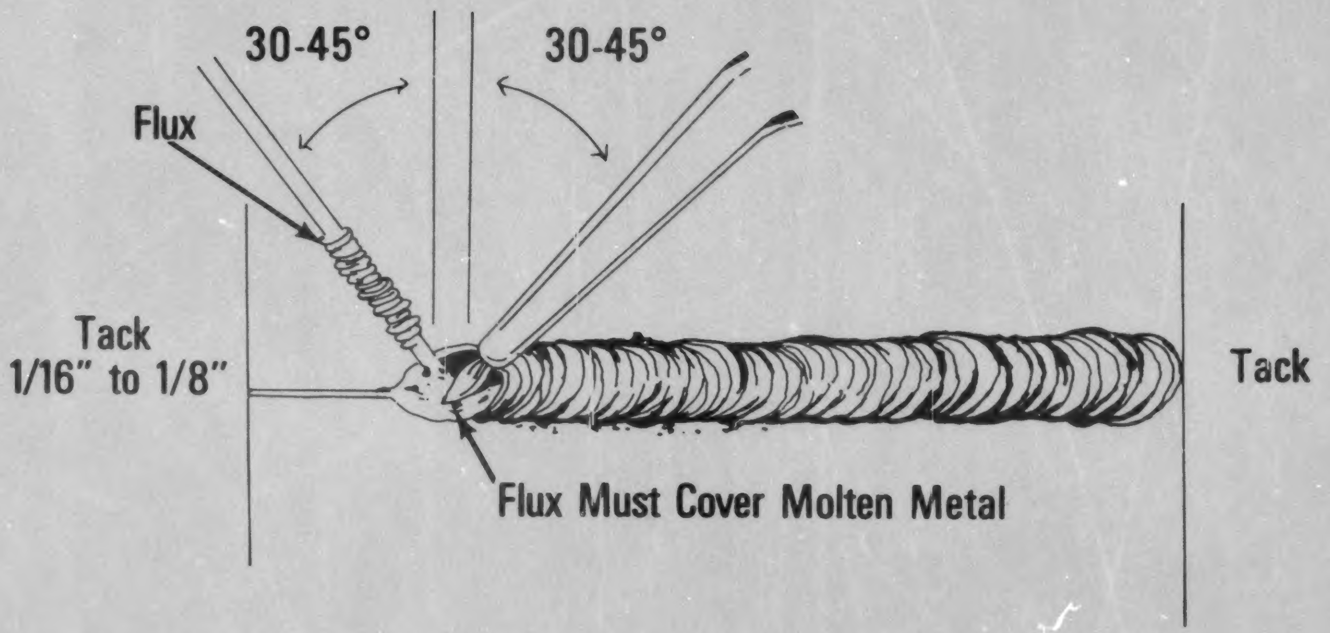
INFORMATION SHEET

B. If the base metal is too hot, the molten bronze tends to boil and form little balls

C. When the base metal is at the proper temperature, the molten bronze will spread out evenly and flow over a considerable area

(NOTE: In this state the base metal is a dull red color.)

Braze Welding A Butt Joint


30-45°
30-45°
Flux
Tack
1/16" to 1/8"
Tack
Flux Must Cover Molten Metal

OXYACETYLENE BRAZE WELDING
UNIT II

JOB SHEET #1--BRAZE WELD A SQUARE GROOVE BUTT JOINT

I. Tools and materials needed

   A. Oxyacetylene welding unit

   B. Gloves

   C. Safety glasses

   D. Goggles

   E. Welding tip (According to manufacturer's recommendations)

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Two pieces of clean mild steel strips, 1 1/4" by 6"

   J. Bronze filler rod (Use according to manufacturer's recommendations)

   K. Welding flux

II. Procedure

   A. Prepare metal for brazing--clean

   B. Place metal in brazing position--1/16" to 1/8" apart

   C. Turn on oxyacetylene unit

   D. Adjust proper working pressure of oxygen and acetylene (Use manufacturer's recommendations)

   E. Place metal on fire brick

      (NOTE: Do not lay metal flat on brick. Arrange metal so a small space will be between the base metal and the fire brick.)

   F. Light and adjust torch to a neutral or slightly oxidized flame

   G. Preheat the end of the brazing rod and dip in the flux or use fluxed rod

   H. Tack metal in place using braze filler metal

JOB SHEET #1

I. Heat the surface of the weld area slightly

J. Hold torch 30° to 45° from vertical; hold filler rod at the same angle in opposite direction

K. Melt a small amount of bronze rod onto the surface and allow it to spread along the entire seam when a dull cherry-red color occurs

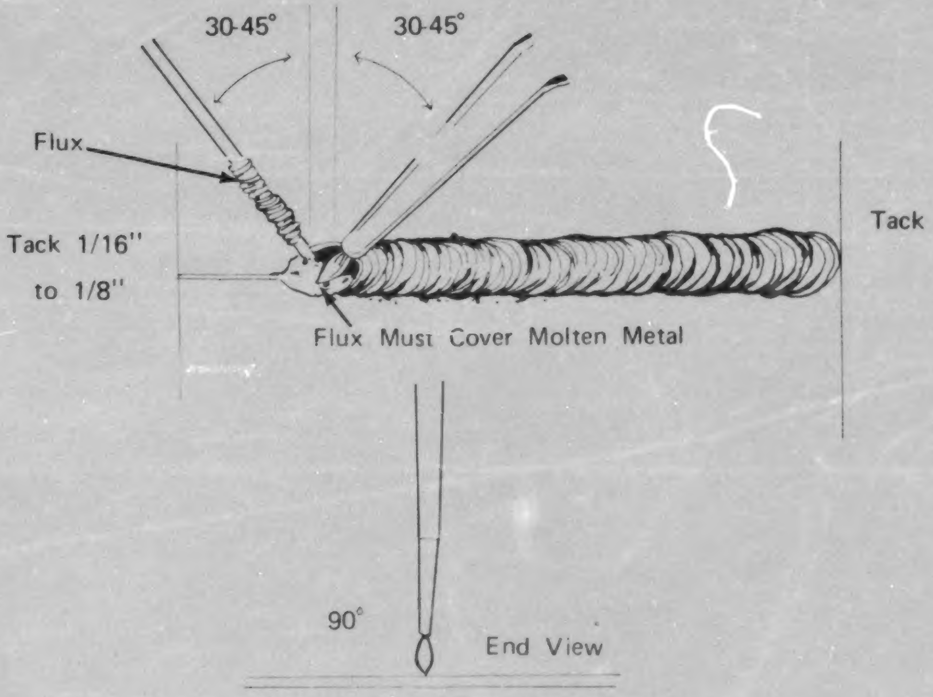
L. When the base metal is tinned sufficiently, start depositing the proper size bead

M. Watch for base metal color

(NOTE: When metal is not hot enough, the bronze will form into drops; when metal is too hot, bronze tends to boil. This is indicated by excessive white smoke.)

N. Inspect weld, then check with instructor

III. Diagram of the procedure


30-45°
30-45°
Flux
Tack 1/16" to 1/8"
Tack
Flux Must Cover Molten Metal
90°
End View

OXYACETYLENE BRAZE WELDING
UNIT II

TEST

1. Match the terms on the right to the correct definition.

   _____a. A chemical used to clean metals and to promote fusion during the welding process

   _____b. A term describing metal which is capable of being drawn or stretched out

   _____c. A property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness

   _____d. Heating the base metal to a dull red color and depositing a bead over the seam (joint) with a bronze filler rod; the base metal is not melted

   _____e. Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)

   1. Malleability
   2. Flux
   3. Braze welding
   4. Ductile
   5. Tinning operation

2. State the differences between brazing and braze welding procedures.

3. List three advantages of braze welding.

    a.

    b.

    c.

4. List three disadvantages of braze welding.

    a.

    b.

    c.

5. List four characteristics of the elements found in the filler rods used in braze welding.

    a.

    b.

    c.

    d.

6. State the importance of having a clean metal surface in braze welding.

7. Name the procedures for removing oxides from a clean metal surface.

    a.

    b.

8. Name five purposes of flux.

    a.

    b.

    c.

    d.

    e.

9. Name the color of the base metal when the proper temperature is obtained in braze welding.

10. Describe the reaction of the molten bronze when the temperature of the base metal is:

    a. Medium (dull red color)

    b. Too hot

    c. Not hot enough

11. Demonstrate the ability to braze weld a square groove butt joint.

    (NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)

OXYACETYLENE BRAZE WELDING
UNIT II

ANSWERS TO TEST

1. a. 2 d. 3

   b. 4 e. 5

   c. 1

2. a. Brazing--A group of welding processes wherein coalescence (the forming together in one mass) is brought about by

      1. Having a joint which requires only a thin film of filler metal

      2. The distribution of filler metal between the closely fitted surfaces of the joint by capillary attraction

   b. Braze welding--Performed in the same manner as fusion welding except that the base metal is not melted

      1. The joint design is the same as used in fusion welding

      2. The welding technique used for braze welding is the same as in fusion welding except that the base metal is raised only to the "tinning" temperature

3. a. Less need for extensive preheating

   b. The low degree of heat minimizes expansion and contraction forces

   c. Less possibility of destroying the main characteristics of the base metal

4. Any three of the following

   a. Not recommended for parts which are to be raised to temperatures higher than the melting point of bronze, either in service or during heat treatment

   b. It cannot be used on metal where stress is a factor

   c. Bronze may have corrosion-resistant properties which differ from those of the base metal being used

   d. Bronze will lose its strength at temperatures above 500° F.

5. Any four of the following

   a. Deoxidize the weld metal

   b. Decrease the tendency to fume

c. Increase the free-flowing action of the molten metal

d. Increase the hardness of the deposited metal for greater wear resistance

e. Produce a high tensile strength

f. Increase ductility

6. a. To guarantee the molten bronze will stick to the base metal

b. To have a stronger bond on base metal

7. a. Mechanical--Wire brush or grinder

b. Chemical--Flux

8. Any five of the following

a. Chemically cleans the base metal

b. Prevents oxidation of the filler metal

c. Floats and removes the oxides already present

d. Increases the flow of the filler metal

e. Increases the ability of the filler metal to adhere to the base metal

f. Brings the filler metal into immediate contact with the metals being joined

g. Permits the filler metal to penetrate the pores of the base metal

9. Dull red

10. a. The molten bronze will spread out evenly and flow over a considerable area

b. The molten bronze will tend to boil and to form little balls

c. The molten bronze will not flow over the surface but will form into drops

11. Performance skills will be evaluated according to the criteria listed on the progress chart.

OXYACETYLENE CUTTING
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to light, adjust, and turn off an oxyacetylene cutting outfit following the proper order and safety precautions. He should also be able to make ninety degree cuts, level cuts, and cut holes in mild steel. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with oxyacetylene cutting to the correct definition.
2. Identify the parts of the torch body and cutting attachment.
3. List the purposes of a slag box.
4. List five reasons for poor cuts.
5. List four causes of a backfire.
6. Describe the results when a backfire takes place.
7. Describe the results when a flashback takes place.
8. List in the proper order the steps to follow in case of a flashback.
9. Demonstrate the ability to:
    a. Set up equipment for oxyacetylene cutting.
    b. Turn on, light, and adjust to a neutral flame and turn off oxyacetylene cutting equipment.
    c. Make ninety degree cuts in mild steel and restart a cut.
    d. Make a flame beveled cut on mild steel plate.
    e. Cut a hole in mild steel.

OXYACETYLENE CUTTING
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency master: TM 1--Parts of a Torch Body and Cutting Attachment

  D. Job sheets

    1. Job Sheet #1--Set Up Equipment for Oxyacetylene Cutting

    2. Job Sheet #2--Turn On, Light, and Adjust the Cutting Torch to a Neutral Flame and Turn Off the Oxyacetylene Cutting Equipment

3. Job Sheet #3--Make Ninety Degree Cuts on Mild Steel and Restart a Cut
4. Job Sheet #4--Make a Flame Beveled Cut on Mild Steel Plate
5. Job Sheet #5--Cut a Hole in Mild Steel

E. Test

F. Answers to test

II. References:

A. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. *Modern Welding.* Homewood, Illinois: The Goodheart-Willcox, Co.

B. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. *Farm Mechanics Text and Handbook.* Danville, Illinois: Interstate Printers and Publishers, Inc.

C. *Smith's Short Course for Gas Cutting, Welding, and Brazing.* Minneapolis, Minnesota: Education Department of Smith Welding Equipment, Division of Tescom Corporation.

D. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures.* New York: Union Carbide Corporation, Linde Division.

OXYACETYLENE CUTTING
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Flashback--Fire inside torch

(CAUTION: This is a very dangerous condition.)

B. Backfire--Momentary burning back of the flame into the tip

C. Flame cutting--A process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high purity oxygen flowing under pressure through a cutting torch

(NOTE: As the metal is oxidized, the preheat flame maintains the temperature necessary to keep the oxidation process going in a narrow zone across the length of the base metal.)

D. Slag box--Metal container with a layer of water or sand to catch hot slag

E. Drag line--Refers to the situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

F. Kerf--Area where the metal was removed in the form of an oxide during the cutting process

G. Oxide--Term usually applied to rust, corrosion, coating, film, or scale

(NOTE: Oxygen combines with the metal causing oxides.)

H. Oxidizing--Combining oxygen with another substance

Example: A metal is oxidized when the metal is cut

II. Parts of a cutting torch and tip (Transparency 1)

A. Cutting torch

1. Oxygen fitting
2. Acetylene fitting
3. Oxygen torch valve
4. Acetylene torch valve
5. Torch body

INFORMATION SHEET

6. Oxygen cutting lever
7. Oxygen preheat valve
8. Tip nut
9. Slip-in tip

B. Cutting tip

1. Preheat orifice--Heats metal to kindling point (cherry red) of approximately 1600° F.
2. Cutting orifice--Removes oxidized metal

(NOTE: The selection of the correct tip for the job is determined by the thickness of metal, size of tip orifices, and the oxygen cutting pressures. See manufacturer's recommendations.)

III. Purposes of slag box

A. To catch hot slag

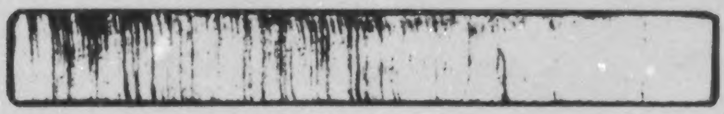
B. To prevent fire

C. To protect clothing

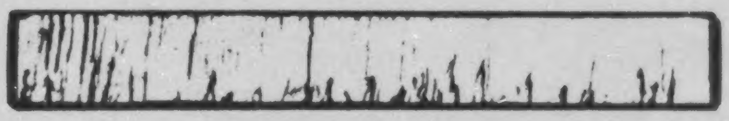
D. To protect welding hoses

IV. Reasons for poor cuts

A. This is a correctly made cut in 1 inch plate; the edge is square and the draglines are essentially vertical and not too pronounced

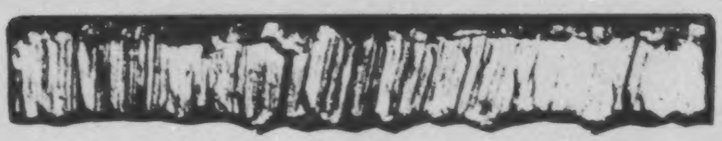


B. Preheat flames were too small for this cut with the result that the cutting speed was too slow, causing bad gouging at the bottom

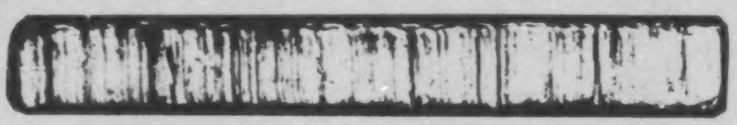


INFORMATION SHEET

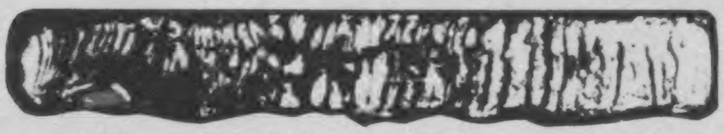
C. Preheat flames were too long with the result that the top surface has melted over, the cut edge is irregular, and there is an excessive amount of adhering slag



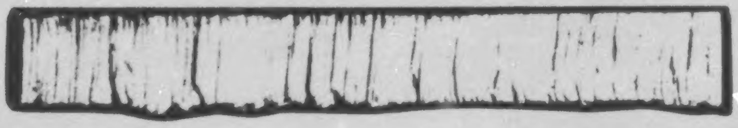
D. Oxygen pressure was too low with the result that the top edge has melted over because of the too slow cutting speed



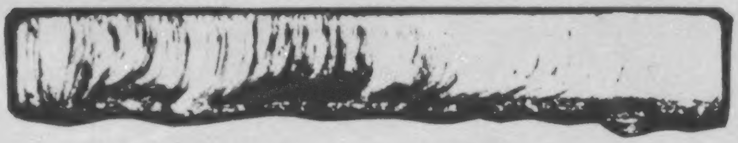
E. Oxygen pressure was too high and the nozzle size too small with the result that the entire control of the cut has been lost



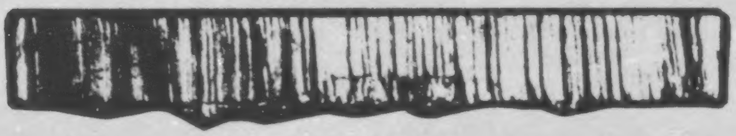
F. Cutting speed was too slow with the result that the irregularities of the draglines are emphasized



G. Cutting speed was too high with the result that there is a pronounced break to the dragline and the cut edge is irregular



H. Blowpipe travel was unsteady with the result that the cut edge is wavy and irregular



INFORMATION SHEET

- I. Cut was lost and not carefully restarted with the result that bad gouges were caused at the restarting point

V. Causes of backfire

- A. Insufficient acetylene or oxygen pressure
- B. Loose cutting tip
- C. Dirty tip
- D. Overheating of cutting tip
- E. Bad O-ring in torch body

(NOTE: The above causes should be carefully checked to control backfire.)

VI. Results of a backfire

- A. Flame burns momentarily back into tip
- B. A loud snap or pop results
  - 1. Flame may go out
  - 2. Flame may continue to burn in normal manner

VII. Results of flashback

- A. Fire inside torch
- B. Disappearance of flame followed by
  - 1. Squealing or hissing noise inside torch
  - 2. Sparks coming from the torch
  - 3. Smoke coming from the torch

VIII. Steps to follow in case of flashback

- A. Close oxygen preheat valve
- B. Close oxygen torch valve

INFORMATION SHEET

C. Close acetylene torch valve

D. Release oxygen regulator screw

E. Release acetylene regulator screw

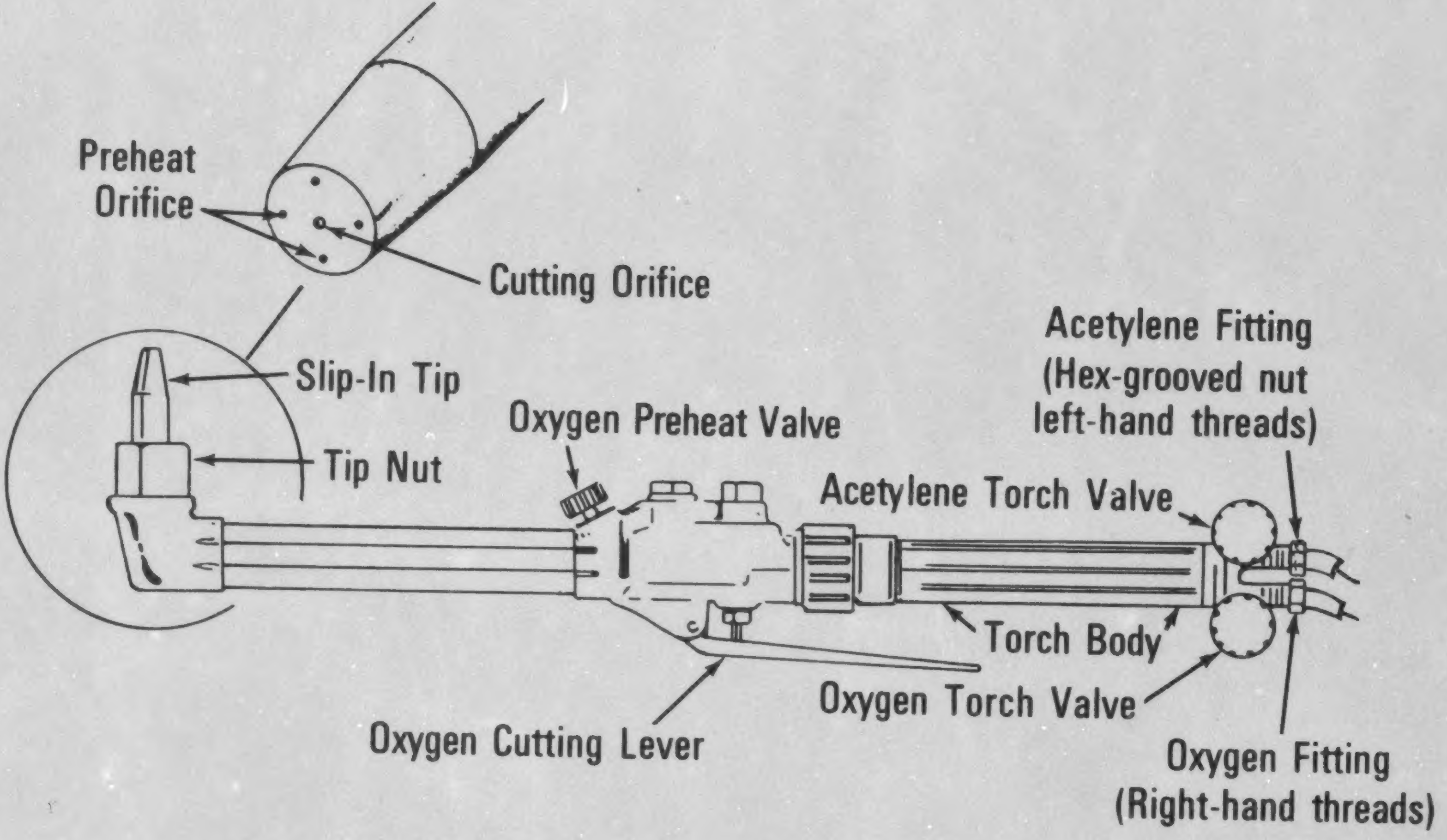
F. Examine acetylene unit

G. Reset regulator pressures

H. Light torch

(NOTE: If heavy smoke comes out of the torch tip and the torch body becomes hot, the flashback has probably traveled past the mixing chamber into the hose. In this case, shut off the oxygen cylinder valve and the acetylene cylinder valve, then notify your instructor.)

Parts of a Torch Body and Cutting Attachment


Preheat Orifice
Cutting Orifice
Slip-In Tip
Tip Nut
Oxygen Preheat Valve
Acetylene Fitting (Hex-grooved nut left-hand threads)
Acetylene Torch Valve
Torch Body
Oxygen Torch Valve
Oxygen Cutting Lever
Oxygen Fitting (Right-hand threads)

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #1--SET UP EQUIPMENT FOR OXYACETYLENE CUTTING

I. Tools and materials needed

  A. Oxygen cylinder

  B. Acetylene cylinder

  C. Oxygen regulator

  D. Acetylene regulator

  E. Hoses

  F. Wrench

  G. Cylinder holder

  H. Water container

  I. Ivory soap

  J. Clean paint brush

  K. Torch body with tips

II. Procedure

  A. Fasten cylinders in a vertical position

  B. Remove caps from cylinders

  C. Crack valves of each cylinder, then close valves

  D. Connect oxygen regulator to oxygen cylinder

    1. Turn adjusting screw on regulator counterclockwise until tension on spring is released

    2. Slowly turn cylinder valve wide open

  E. Connect acetylene regulator to acetylene cylinder

    1. Turn adjusting screw on regulator counterclockwise until tension on spring is released

    2. Open cylinder valve 1/2 to 3/4 of a turn (never more than 1 1/2 turns)

  F. Connect acetylene hose to acetylene regulator and purge hose

  G. Connect oxygen hose to oxygen regulator and purge hose

JOB SHEET #1

H. Connect torch body to oxygen and acetylene hose and close both valves on torch body

I. Attach cutting attachment to torch body

(NOTE: The size tip is determined by the thickness of metal to be cut and the manufacturer's recommendations.)

J. Close oxygen preheat valve on cutting attachment

K. Turn adjusting screw on oxygen regulator clockwise until working pressure is reached

L. Turn adjusting screw on acetylene regulator clockwise until correct working pressure is reached

M. Test all connections for leaks with Ivory soap suds and water

(NOTE: Apply soap suds with a clean paint brush.)

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #2--TURN ON, LIGHT, AND ADJUST THE CUTTING TORCH TO A NEUTRAL FLAME AND TURN OFF THE OXYACETYLENE CUTTING EQUIPMENT

I. Tools and materials needed

A. Oxygen cylinder

B. Acetylene cylinder

C. Hoses

D. Oxygen and acetylene regulators

E. Torch body

F. Cutting attachment with slip in tip

G. Cylinder holder and hose rack

H. Flint lighter

I. Wrench

J. Gloves

K. Safety goggles

L. Coveralls or protective clothing

II. Procedure for turning on, lighting, and adjusting the cutting torch to a neutral flame

A. Check all cylinder, regulator, and torch valves to make sure they are off

B. Open acetylene cylinder valve 1/2 to 3/4 of a turn (never more than 1 1/2 turns)

C. Open acetylene valve on torch one turn

JOB SHEET #2

- D. Turn adjusting screw on acetylene regulator clockwise until desired pressure is reached*
- E. Close acetylene valve on torch
- F. Open oxygen cylinder valve all the way
- G. Open oxygen torch valve all the way
- H. Open oxygen preheat valve on cutting attachment one turn
- I. Turn adjusting screw on oxygen regulator clockwise until desired pressure is reached*
- J. Close oxygen preheat valve on cutting attachment
- K. Open acetylene valve on torch 1/4 turn
- L. Light the torch with flint lighter and adjust until smoke on flame clears
- M. Open oxygen preheat valve slowly and adjust to a neutral flame
- N. Depress the oxygen cutting lever and check to see that a neutral flame is present

  (NOTE: If necessary, adjust the oxygen preheat valve with the oxygen cutting lever depressed until a neutral flame is secured.)

  (*NOTE: Oxygen and acetylene pressures and size of tip depend upon the thickness of metal to be cut. Use pressures and tip size recommended by manufacturer.)

III. Procedure for turning off the flame and oxyacetylene unit

- A. Close acetylene valve on torch
- B. Close oxygen preheat valve
- C. Close acetylene cylinder valve
- D. Close oxygen cylinder valve
- E. Open acetylene valve on torch

  (NOTE: When gauges reach 0, close torch valve and release adjusting screw on acetylene regulator by turning counterclockwise.)

JOB SHEET #2

F. Open oxygen preheat valve on torch

(NOTE: When gauges reach 0, close oxygen preheat valve and release adjusting screw on oxygen regulator by turning counterclockwise.)

G. Close oxygen valve on torch

H. Place torch and hose on hanger or brackets provided

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #3--MAKE NINETY DEGREE CUTS ON MILD STEEL AND RESTART A CUT

I. Tools and materials needed

  A. Cutting outfit with tip assembly

  B. Mild steel plate 4" wide or wider, 8" long or longer

  C. Soapstone with a sharp point or edge

  D. Straightedge

  E. Gloves

  F. Safety goggles

  G. Pliers

  H. Coveralls

  I. Flint lighter

  J. Welding or cutting table

  K. Slag box

  L. Can of water

  M. Cutting tip

II. Procedure

  A. Mark four parallel lines 2" apart on plate to be cut

  B. Adjust oxygen regulator

  C. Adjust acetylene regulator

  D. Place plate to be cut over slag box

  E. Light torch

  F. Adjust to neutral flame

  G. Assume comfortable position

JOB SHEET #3

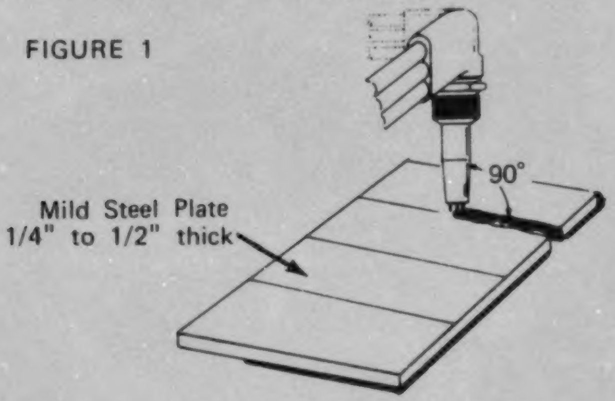
H. Place hoses behind operator

I. Maneuver torch with both hands

J. Hold preheat flame with tip of inner cone 1/16" to 1/8" above top of plate at right edge until red spot appears

K. Depress the oxygen cutting lever, and move from right to left across the plate (for left-handed operators, go from left to right) (Figure 1)

FIGURE 1



L. Hold the tip at right angles to work while cutting with inner cone being 1/16" to 1/8" above work

M. Make 90° cuts until you have developed the proper procedure

N. Cool metal by placing in can of water with the aid of pliers

O. Show samples to instructor for approval and grading

III. Procedure for restarting a cut

A. Release the oxygen cutting lever

B. Preheat edge (only) where cutting action was stopped

C. Slowly depress oxygen cutting lever and continue cut

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #4--MAKE A FLAME BEVELED CUT ON MILD STEEL PLATE

I. Tools and materials needed

A. Cutting outfit with tip assembly

B. Mild steel plate 4" wide or wider, 8" long or longer

C. Soapstone with a sharp point or edge

D. Straightedge

E. Gloves

F. Safety goggles

G. Pliers

H. Coveralls

I. Flint lighter

J. Welding or cutting table

K. Slag box

L. Can of water

M. Cutting tip

II. Procedure

A. Place one piece of 3/8" to 1/2" plate 2" x 6" on slag box or cutting table

B. Light and adjust cutting torch to a neutral flame

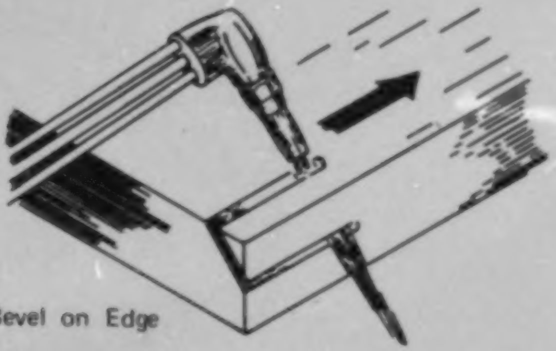
(NOTE: Oxygen cutting pressures are greater for bevel cuts than 90° cuts.)

C. Place hoses behind operator

JOB SHEET #4

D. Hold torch with both hands at desired angle to metal as shown (Figure 1)

FIGURE 1



E. Hold preheat flame with tip of inner cone (neutral flame) 1/16" to 1/8" above top of plate until bright red spot appears

F. Depress oxygen cutting lever and proceed across plate with very consistent movement being careful to maintain constant travel speed, torch angle, and flame to work distance

G. Practice until you develop the proper procedure

H. Turn in exercises for instructor's approval and grading

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #5--CUT A HOLE IN MILD STEEL

I. Tools and materials needed

   A. Cutting outfit with tip

   B. Mild steel plates (prepared in Job Sheet #1)

   C. Soapstone with a sharp point or edge

   D. Straightedge

   E. Gloves

   F. Safety goggles

   G. Pliers

   H. Coveralls

   I. Flint lighter

   J. Welding or cutting table

   K. Slag box

   L. Can of water

II Procedure

   A. Draw two circles on metal

      1. 1" in diameter, 1" from edge

      2. 1/2" in diameter, 1" from edge

   B. Adjust oxygen regulator

   C. Adjust acetylene regulator

   D. Place metal to be cut over slag box

   E. Light torch

   F. Adjust to neutral flame

   G. Assume comfortable position

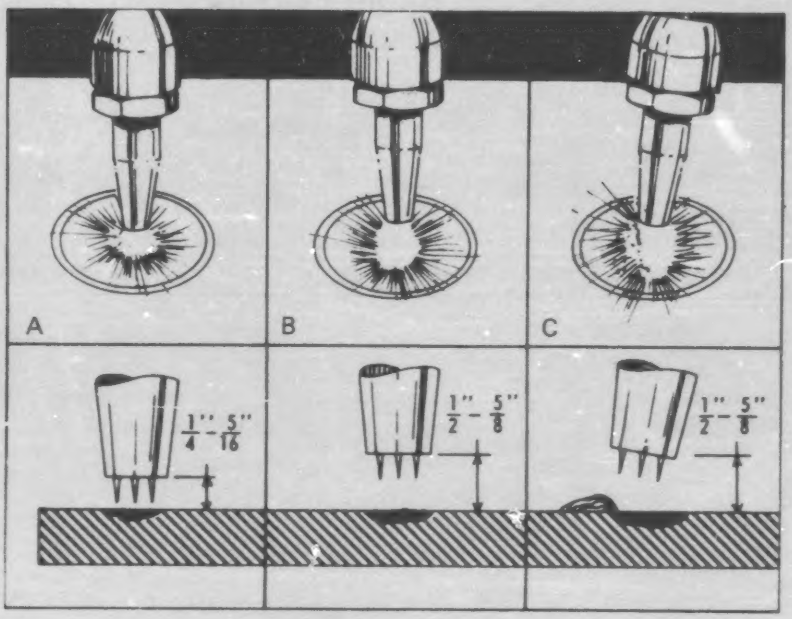
JOB SHEET #5

H. Place hoses behind operator

I. Maneuver torch with both hands

J. Hold tip of inner cone 1/16" to 1/8" above point to be cut until metal turns bright red (Figure 1)

FIGURE 1



1. Tilt torch 15° from vertical position

   (NOTE: This will allow molten metal to be blown away from operator.)

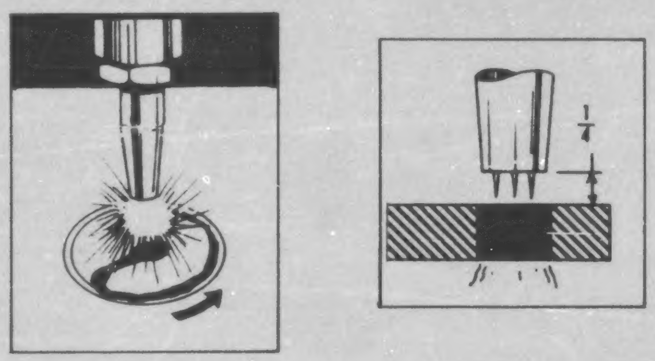
2. Depress oxygen cutting lever slowly moving torch backwards (to the operator's right if right-handed) until cut pierces plate

JOB SHEET #5

K. Return cutting torch to vertical position

1. Raise cutting tip until tip of inner cone is from 1/4" to 1/2" above the plate
2. Make cut (Figure 2)

FIGURE 2



L. Cut just inside soapstone mark until circular cut is completed

M. Repeat steps K and L until all holes are cut

N. Cool metal by placing in can of water with the aid of pliers

O. Show samples to instructor for approval and grading

OXYACETYLENE CUTTING
UNIT III

TEST

1. Match the terms on the right with the correct definition.

_____a. Fire inside torch

_____b. Momentary burning back of the flame into the tip

_____c. A process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high purity oxygen flowing under pressure through a cutting torch

_____d. Metal container with a layer of water or sand to catch hot slag

_____e. Refers to the situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

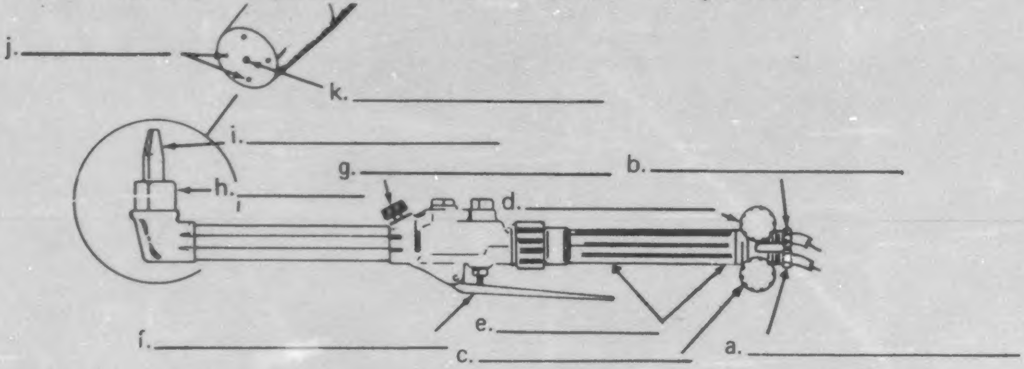
_____f. Area where the metal was removed in the form of an oxide during the cutting process

_____g. Term usually applied to rust, corrosion, coating, film, or scale

_____h. Combining oxygen with another substance

1. Kerf
2. Backfire
3. Slag box
4. Flashback
5. Flame cutting
6. Oxide
7. Drag line
8. Oxidizing

2. Identify the parts of the torch body and cutting attachment.



3. List the purposes of a slag box.
   - a.
   - b.
   - c.
   - d.

4. List five reasons for poor cuts.
   - a.
   - b.
   - c.
   - d.
   - e.

5. List four causes of a backfire.
   - a.
   - b.
   - c.
   - d.

6. Describe the results when a backfire takes place.

7. Describe the results when a flashback takes place.

8. List in the proper order the steps to follow in case of a flashback.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

9. Demonstrate the ability to:

   a. Set up equipment for oxyacetylene cutting.

   b. Turn on, light, and adjust to a neutral flame and turn off the oxyacetylene cutting equipment.

   c. Make 90° cuts on mild steel and restart a cut.

   d. Make a flame beveled cut on mild steel plate.

   e. Cut a hole in mild steel.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

OXYACETYLENE CUTTING
UNIT III

ANSWERS TO TEST

1. a. 4
   b. 2
   c. 5
   d. 3
   e. 7
   f. 1
   g. 6
   h. 8

2. a. Oxygen fitting
   b. Acetylene fitting
   c. Oxygen torch valve
   d. Acetylene torch valve
   e. Torch body
   f. Oxygen cutting lever
   g. Oxygen preheat valve
   h. Tip nut
   i. Slip-in tip
   j. Preheat orifice
   k. Cutting orifice

3. a. To catch hot slag
   b. To prevent fire
   c. To protect clothing
   d. To protect welding hoses

4. Any five of the following
   a. Preheat flames too small causing cutting speed to be too slow
   b. Preheat flames too long
   c. Oxygen pressure too low

    d. Oxygen pressure too high and nozzle size too small
    e. Cutting speed too slow
    f. Cutting speed too high
    g. Blowpipe travel unsteady
    h. Cut lost and not carefully restarted

5. Any four of the following
    a. Insufficient acetylene or oxygen pressure
    b. Loose cutting tip
    c. Dirty tip
    d. Overheating of cutting tip
    e. Bad O-ring in torch body

6. Description should include:
    a. Flame burns momentarily back into tip
    b. A loud snap or pop results
        1) Flame may go out
        2) Flame may continue to burn in normal manner

7. Description should include:
    a. Fire inside torch
    b. Disappearance of flame followed by
        1) Squealing or hissing noise inside torch
        2) Sparks coming from torch
        3) Smoke coming from torch

8. a. Close oxygen preheat valve
    b. Close oxygen torch valve
    c. Close acetylene torch valve
    d. Release oxygen regulator screw

e. Release acetylene regulator screw

f. Examine acetylene unit

g. Reset regulator pressures

h. Light torch

9. Performance skills will be evaluated according to the criteria listed on the progress chart.

SHIELDED METAL ARC WELDING
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to name three kinds of arc welders, distinguish between straight and reverse polarity, and select the correct electrode for the job. He should be able to demonstrate the ability to start, stop, and restart a bead, construct a pad in a flat position, and construct a square groove butt weld. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with shielded metal arc welding with the correct definition.
2. Name four types of arc welding machines.
3. Name the common equipment needed in shielded metal arc welding.
4. Distinguish between straight and reverse polarity.
5. Select from a list factors that determine the polarity to use in shielded metal arc welding.
6. Name the two types of operating adjustments found on arc welding machines.
7. Discuss in a short paragraph the procedure to follow in testing for polarity.
8. Name four common types of electrodes.
9. Name four common sizes of electrodes.
10. Select from a list the factor that determines electrode size.
11. Select from a list the purposes of flux coating on electrodes.
12. Identify the meaning of the numbers in the AWS electrode code classification.
13. Name five factors to be considered when selecting an electrode for a specific job application.
14. Name four types of welds.

15. Identify the parts of groove and fillet welds.

16. Identify five types of weld joints.

17. Select reasons for poor welds when given a list of alternatives.

18. Identify the parts of the welding process when presented a drawing of the process.

19. Name the two methods of striking an arc.

20. Name five safety precautions to follow in shielded metal arc welding.

21. Match the correct lens shade number to the type of welding operation.

22. Demonstrate the ability to perform the following tasks:

    a. Start, stop, and restart a bead.

    b. Strike an arc and construct a pad in flat position, using E-6010 rod, by running uniform beads on mild steel plate which is one-fourth inch to three-eighths inch thick.

    c. Construct a square groove butt weld on three-sixteenths inch or one-fourth inch steel plate with one-hundred percent penetration, using a single pass with E-6010 rod.

SHIELDED METAL ARC WELDING
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives with students.

  E. Discuss information sheet.

  F. Demonstrate and discuss the procedures outlined in the job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Welding Circuit

    2. TM 2--Standardized AWS Classification

    3. TM 3--Types of Welds

    4. TM 4--Parts of a Weld

    5. TM 5--Types of Joints

    6. TM 6--Direction of Travel

D. Job sheets

  1. Job Sheet #1--Start, Stop, and Restart the Arc

  2. Job Sheet #2--Make a Pad in the Flat Position

  3. Job Sheet #3--Make a Square Groove Butt Weld

E. Test

F. Answers to test

II. References:

A. Jones, M. M. *Shopwork on the Farm*. New York: McGraw-Hill Book Company, Inc.

B. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. *Farm Mechanics Text and Handbook*. Danville, Illinois: The Interstate Printers and Publishers, Inc.

C. Kugler, Harold L. *Arc Welding Lessons for School and Farm Shop*. Cleveland, Ohio: James F. Lincoln Arc Welding Foundation.

D. Hollenberg, A. H. *How to Teach Arc Welding in Farm Mechanics*. Cleveland, Ohio: James F. Lincoln Arc Welding Foundation.

E. *Hobart Welding School Workbook*. Troy, Ohio: Hobart Brother's Technical Center.

F. *New Lessons in Arc Welding*. Cleveland, Ohio: The Lincoln Electric Company, James F. Lincoln Arc Welding Foundation.

G. *Welding Processes and Power Sources Study Guide and Workbook*. E. R. Pierre, Power Publications Company, P.O. Box 96, Appleton, Wisconsin 54911.

SHIELDED METAL ARC WELDING
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Shielded metal arc welding--Arc welding process wherein metals are united by heating with an electric arc between a coated metal electrode and the metal

B. Arc--Flow of electric current from the tip of the electrode to the base of the metal being welded

C. Electrode--Metal rod which conducts a current from the electrode holder to the base metal

D. Base metal--The metal to be welded or cut

E. Arc length--Distance from the end of the electrode to the point where the arc makes contact with work surface

F. Crater--Depression at the termination of a weld

G. Face of weld--Exposed surface of a weld, made by an arc or gas welding process, on the side from which welding was done

H. Flux--Fusible material or gas used to dissolve and/or prevent the formation of oxides, nitrides, or other undesirable inclusions formed in welding

I. Low carbon steel--Steel containing .20% or less carbon

J. Pass--Single longitudinal progression of a welding operation along a joint or weld deposit

K. Porosity--Gas pockets or voids in metal

L. Spatter--Metal particles given off during welding which do not form a part of the weld

M. Tack weld--Weld made to hold parts in proper alignment until the final welds are made

(NOTE: This type of welding is for assembly purposes only.)

N. Puddle--That portion of a weld that is molten at the place the heat is supplied

O. Undercut--Groove melted into the base metal adjacent to the toe of the weld and left unfilled by weld metal

P. Weld metal--That portion of a weld which has been melted during welding

INFORMATION SHEET

Q. Weaving--Technique of depositing weld metal in which the electrode is oscillated

R. Whipping--Term applied to an inward and upward movement of the electrode which is employed in vertical welding to avoid undercut

S. AWS--American Welding Society

T. Disposition rate--Amount of filler metal deposited in any welding process; rate is in pounds per hour

II. Types of arc welding machines

A. AC (Alternating current) transformer welder--Current alternating direction 120 times per second

B. AC-DC transformer rectifier--Provides either alternating current or direct current

C. Motor generator--Produces DC current

D. Engine generator--Produces DC current

III. Common equipment

A. Welding machine

B. Electrode holder with lead

C. Ground clamp with lead

D. Shield or helmet

E. Gloves

F. Chipping hammer

G. Safety goggles

H. Wire brush

I. Electrodes

J. Pliers

K. Protective clothing

INFORMATION SHEET

IV. Polarity (Transparency 1)

A. Reverse--Current flows from base metal to electrode

B. Straight--Current flows from electrode to base metal

(NOTE: Welding leads must connect to correct terminals if machine has a polarity switch. Otherwise a change in polarity is made by reversing leads on the terminals.)

V. Factors that determine polarity--Electrode and type of flux on electrode

Alternatives

A. E-6010 DC (+) reverse polarity

B. E-6012 AC-DC (-) straight polarity

C. E-7018 AC-DC (+) reverse polarity

D. E-7024 AC-DC (+-) reverse or straight polarity

VI. Operating machine adjustments

A. Current (amperage) settings

1. Increasing amps--Produces more heat

2. Decreasing amps--Produces less heat

B. Polarity

VII. Testing for polarity

A. Weld a bead using E-6010 reverse polarity electrode

(NOTE: If there is excessive amount of weld spatter and arc is very erratic, machine is set on straight polarity; electrode lead negative, work lead (ground) positive. Reverse polarity should have electrode positive, work lead (ground) negative. The same practice would apply if machine is set on A.C.)

B. Strike arc with carbon electrode

(NOTE: If arc is smooth and quiet, it is set on straight polarity. If carbon becomes extremely hot and pieces break off and black smudges appear on workpiece, it is set on reverse polarity.)

INFORMATION SHEET

VIII. Types of electrodes

A. Mild steel

B. Low hydrogen-low alloy

C. Nonferrous

D. Hard surfacing

E. Cast iron

F. Stainless steel

Example:

WELDING CHARACTERISTICS AND OPERATING DATA OF MILD STEEL ELECTRODES

	Coating Color	Position of Welding	Type of Current* Used	Penetration	Rate of Deposition	Appearance of Bead	Minimum Tensile Strength	3/32" Size	1/8" Size	5/32" Size	3/16" Size
E6010	White	All Positions	DC, Reverse (+)	Deep	Av. Rate	Rippled and Flat	62,000psi		75-130	90-175	140-225
E6011	White	All Positions	AC DC, Reverse (+)	Deep	Av. Rate	Rippled and Flat	62,000psi		75-120 70-110	90-160 80-145	120-200 110-180
E6012	Tan	All Positions	DC, Str AC (-)	Medium	Good Rate	Smooth and Convex	67,000psi	55-80 60-90	80-135 90-150	110-180 120-200	155-250 170-275
E6013	Dark Tan	All Positions	AC DC, Str. (-) or Reverse	Mild	Good Rate	Smooth, Flat and Convex	67,000psi	65-100 60-90	90-140 80-125	140-200 125-180	200-260 180-235
E7014	Gray Br	All Positions	AC DC, Str. (-) or Reverse	Medium	High Rate	Smooth, Flat and Convex	70,000		110-160 100-145	150-225 1350200	200-280 180-250
E7016		All Positions	AC DC, Reverse (+)	Mild to Medium	Good Rate	Smooth and Convex	70,000	70-100	80-130	120-170	170-250
E7024	Dark Gray	Flat Hor. Fillets	AC, DC Straight or Reverse	Mild	Very High Rate	Smooth and Slightly Cvx	72,000	65-120 60-110	115-175 100-160	180-240 160-215	240-300 220-280
E6027	Red Brown	Flat Hor. Fillets	Flat-DC AC Hor. Fillet DC Str. AC	Medium	Very High Rate	Flat to Concave	62,000psi			190-240 175-215	250-300 230-270
E7018	Gray	All Positions	AC DC, Reverse (+)	Mild	High Rate	Smooth, Flat to Convex	72,000	70-100 80-120	90-150 110-170	120-190 135-225	170-280 200-300
E7028	Gray Br	Flat Hor. Fillets	AC DC, Reverse (+)	Mild	Very High Rate	Smooth and Slightly Cvx	72,000			180-270 170-240	240-330 210-300

*DC Reverse means DC, reverse polarity (electrode positive)
DC Straight means DC, straight polarity (electrode negative)

INFORMATION SHEET

IX. Common electrode sizes

- A. Range in size from 1/16" to 5/16"
- B. Common sizes 3/32", 1/8", 5/32", 3/16", 7/32", 1/4", 5/16"

X. Determining electrode size--Determined by diameter of bare end of electrode

XI. Purposes of flux coating

- A. Stabilizes arc
- B. Shields molten puddle from air
- C. Floats impurities out of puddle
- D. Forms slag and slows cooling
- E. Provides deoxidizers and scavengers to prevent porosity of weld zone
- F. Provides alloying elements for higher strength welds
- G. Provides iron powder to increase the disposition rate

XII. A.W.S. electrode classification (Transparency 2)

- A. E--Stands for electrode
- B. First two digits--Indicate tensile strength deposited in a thousand pounds per square inch
- C. Third number--Indicates welding position
    - 1. All positions
    - 2. Flat and horizontal
- D. Fourth digit--Represents special characteristics and usability of the rod
    - 1. Current
    - 2. Penetration
    - 3. Type of flux coating

XIII. Factors for selecting electrodes

- A. Base metal strength properties
- B. Base metal composition
- C. Welding position

INFORMATION SHEET

- D. Welding current
- E. Joint design and fit-up
- F. Thickness and shape of base metal
- G. Service conditions and/or specification
- H. Production efficiency and job conditions

XIV. Types of welds (Transparency 3)

- A. Bead
- B. Fillet
- C. Groove
- D. Plug

XV. Parts of groove and fillet welds (Transparency 4)

- A. Groove weld
  1. Face
  2. Root
  3. Root face
  4. Root opening
  5. Groove face
  6. Groove angle
  7. Bevel angle
  8. Throat
- B. Fillet weld
  1. Toe
  2. Face
  3. Throat
  4. Leg
  5. Root

INFORMATION SHEET

XVI. Types of weld joints (Transparency 5)

- A. Butt
- B. Corner
- C. T
- D. Lap
- E. Edge

XVII. Reasons for poor welds

- A. Improper machine adjustment
- B. Improper electrode length and size
- C. Improper movement of electrode
- D. Improper angle of electrode
- E. Improper base metal preparation
- F. Improper arc length

XVIII. Parts of welding process (Transparency 6)

- A. Slag
- B. Weld
- C. Electrode
- D. Wire core
- E. Coating
- F. Arc
- G. Crater
- H. Penetration
- I. Base metal
- J. Heat lines
- K. Gaseous shield
- L. 10° - 15°

INFORMATION SHEET

XIX. Methods of striking arc

A. Tapping

B. Scratching

XX. Safety precautions

A. Keep equipment in good, clean, dry condition

B. Make sure all electrical connections are tight, clean, and dry

C. Use correct size welding cable; do not overload

D. Be sure cables, holder, and connections are properly insulated

E. Cut off power to welder before cleaning machine or making internal adjustments

F. Never change polarity or current settings while machine is under load

G. Observe normal operating care for electrical hazards

H. Keep work area neat, clean, and dry

I. Remove flammable materials from welding area, or shield them

J. Do not weld near volatile, flammable liquids or gases

K. Do not weld or cut on containers such as drums, barrels, or tanks until you know there is no danger of fire or explosion

L. Dispose of hot electrode stubs in a metal container

M. Never strike an arc on a compressed gas cylinder

N. Protect your eyes from rays of the arc; wear a headshield with the proper filter plates when welding or cutting

O. Wear protective chipping goggles when chipping off weld slag

(NOTE: Chip away from your face.)

P. Wear leather gloves and protective clothing such as an apron, sleeves, etc. to shield against the arc rays and sparks; button up shirt collar

Q. Use a nonreflecting welding curtain to protect others in the area from the arc rays

INFORMATION SHEET

R. Be sure work area has adequate ventilation-plenty of fresh air; special precautions are necessary when welding lead, zinc, beryllium copper, or cadmium

S. Do not pick up hot metal

T. Always open main switch or disconnect plug when checking over a welder

U. Do not leave electrode holder on welding table or in contact with grounded metal surface

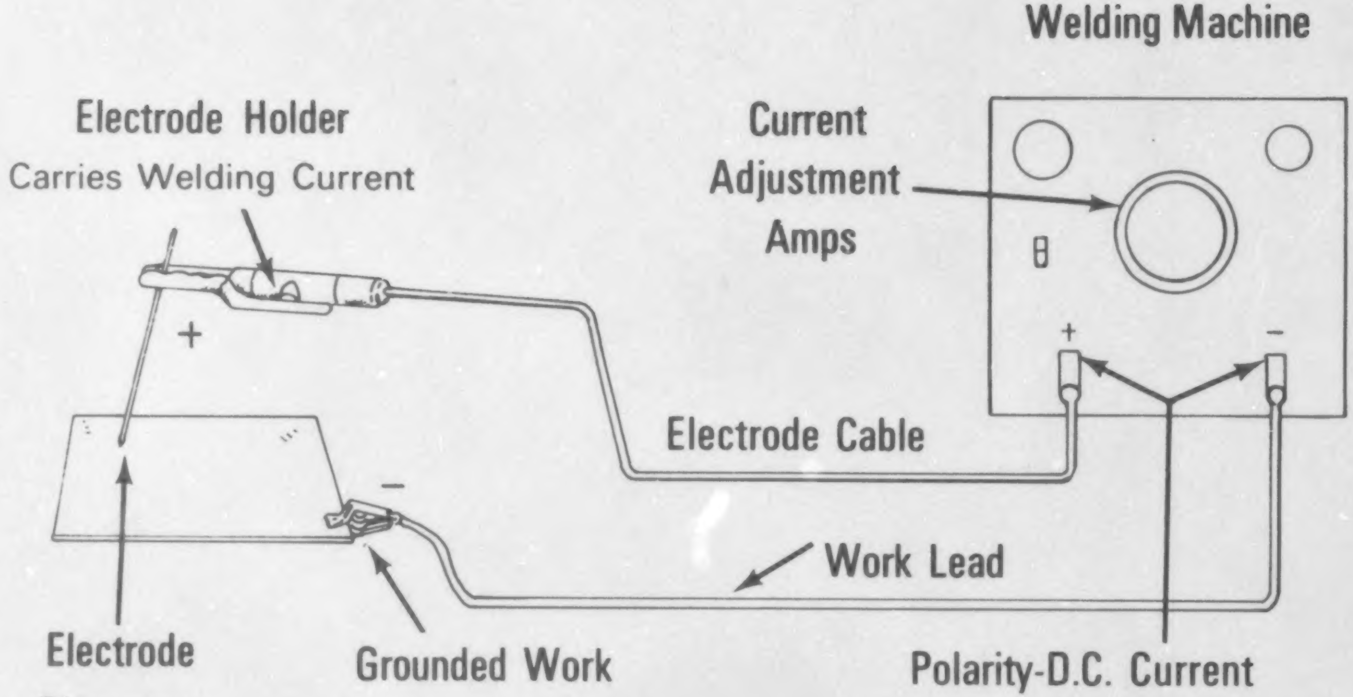
V. Keep tools and metal in their proper locations

XXI. Safety lens

LENS SHADE SELECTOR

Type of operation	Shade number
Soldering	2
Torch brazing	3 or 4
Oxygen cutting	
0 - 1 inch	3 or 4
1 - 6 inches	3 or 5
6 inches and over	5 or 6
Gas welding	
0 - 1/8 inch	4 or 5
1/8 to 1/2 inch	5 or 6
1/2 inch and over	6 or 8
Shielded metal arc welding 1/16, 3/32, 1/8, 5/32 inch electrodes	9 - 14
Gas Metal Arc Welding	9 - 14
Gas tungsten arc welding Nonferrous, gas metal arc welding 1/16, 3/32, 1/8, 5/32 inch electrode	9 - 14
Gas tungsten arc welding (ferrous), gas metal arc welding (ferrous) 1/16, 3/32, 1/8, 5/32 inch electrodes	9 - 14

Welding Circuit



Welding Machine

Electrode Holder

Carries Welding Current

Current Adjustment Amps

Electrode Cable

Work Lead

Electrode

Diameters:
1/16 - 5/16 x 14′
Most Common
Length

Grounded Work

Completes
Welding Circuit

Polarity-D.C. Current

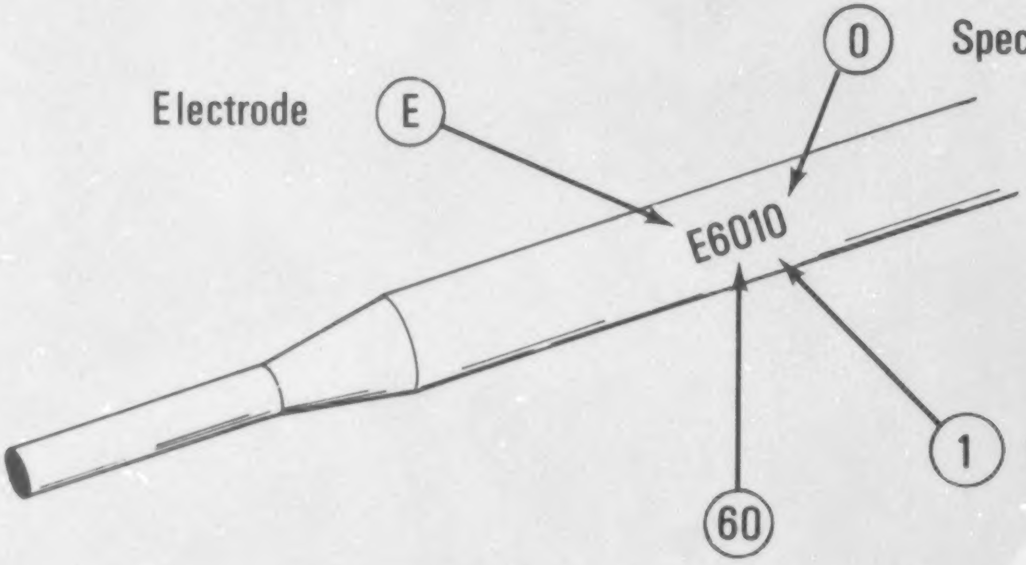
Reverse:

1. Electrode (+)
2. Current flows from work to electrode
3. 2/3 heat at (+) electrode
   1/3 heat at (-) work

Straight:

1. Electrode (-)
2. Current flows from electrode to work
3. 2/3 heat at (-) work
   1/3 heat at (+) electrode

Standardized AWS Classification



Electrode

Special Characteristics

current
penetration
type of flux
coating

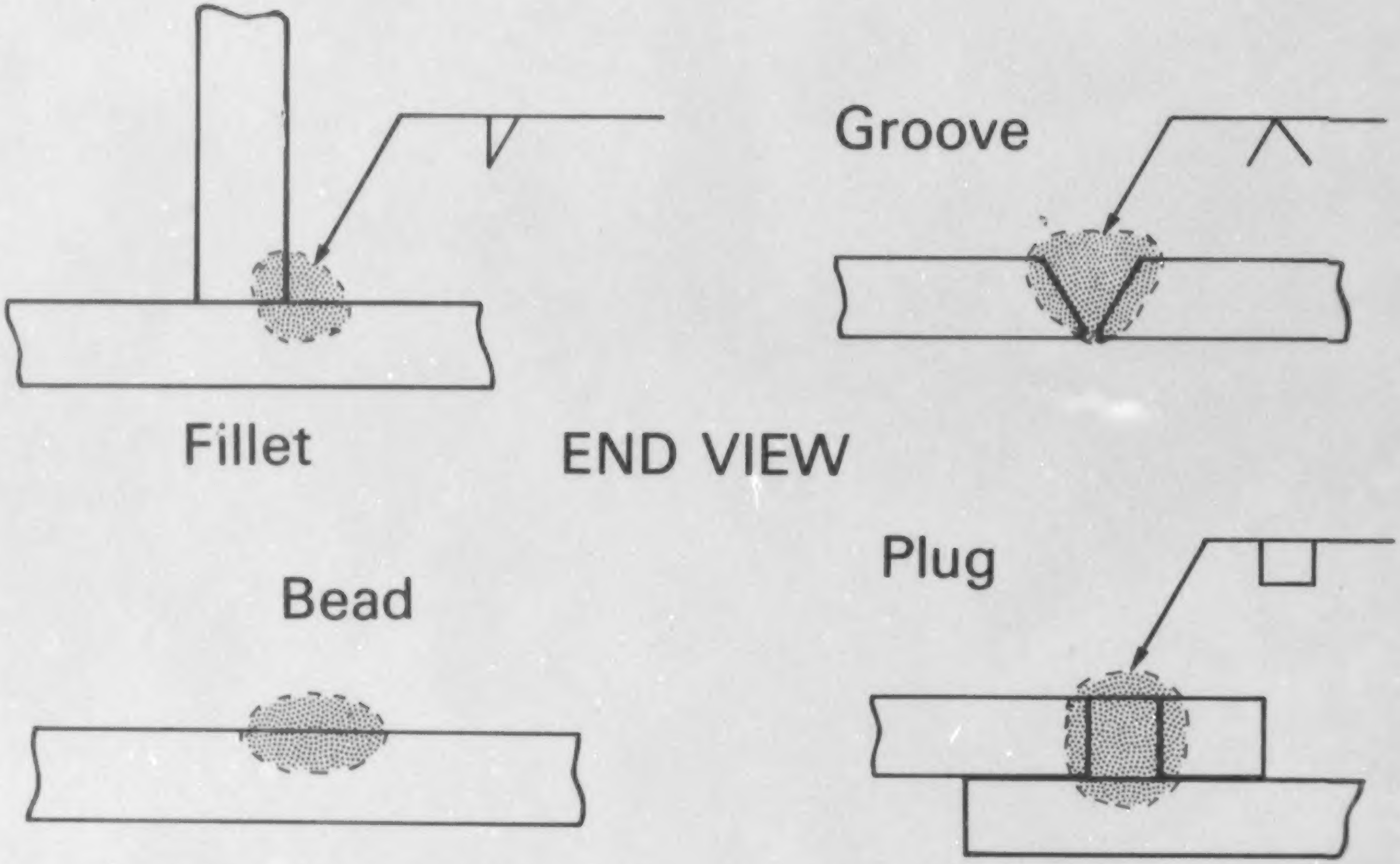
Welding Positions

1. all positions
2. flat and horizontal

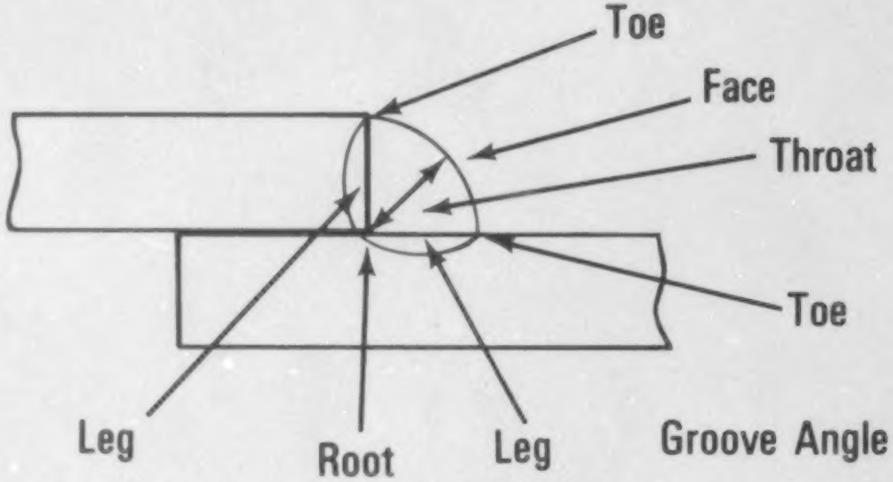
Tensile Strength 1,000 Lbs. Per Sq. Inch

E6010 Mild Steel Electrode

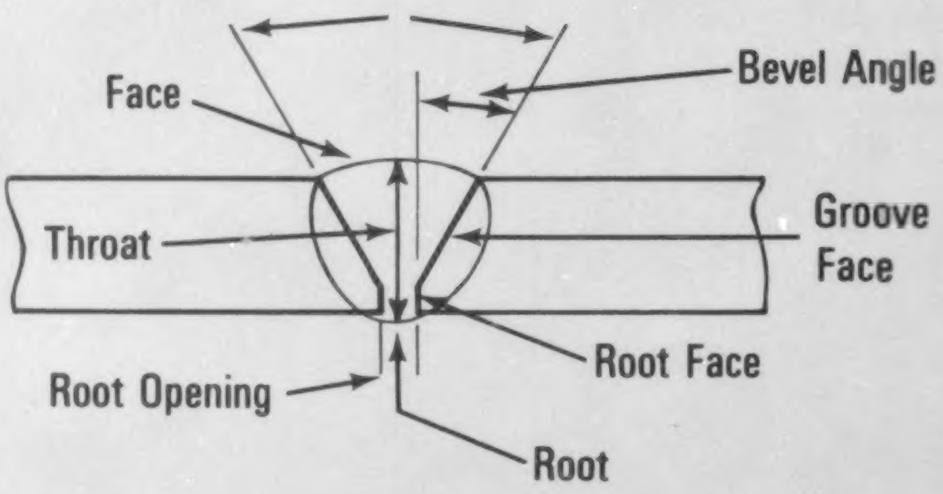
Types of Welds


Fillet
Groove
END VIEW
Bead
Plug

Parts of a Weld


Toe
Face
Throat
Toe
Leg
Root
Leg

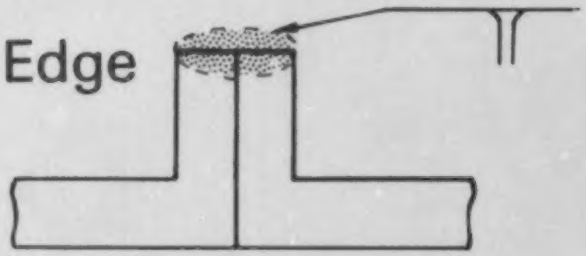
FILLET WELD


Groove Angle
Bevel Angle
Face
Throat
Groove Face
Root Face
Root Opening
Root

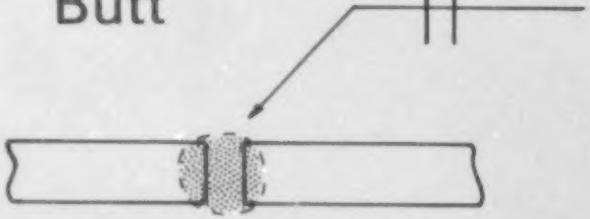
GROOVE WELD

Types of Joints

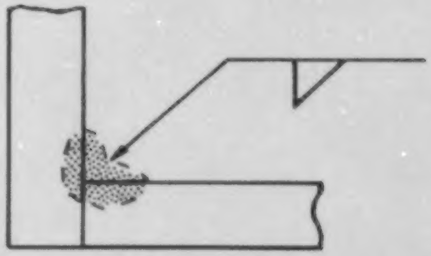
Edge



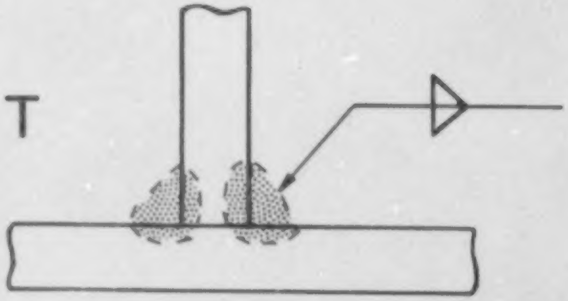
Butt



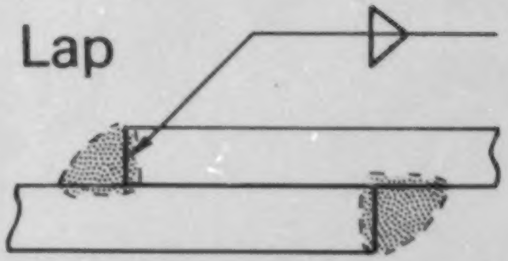
Corner



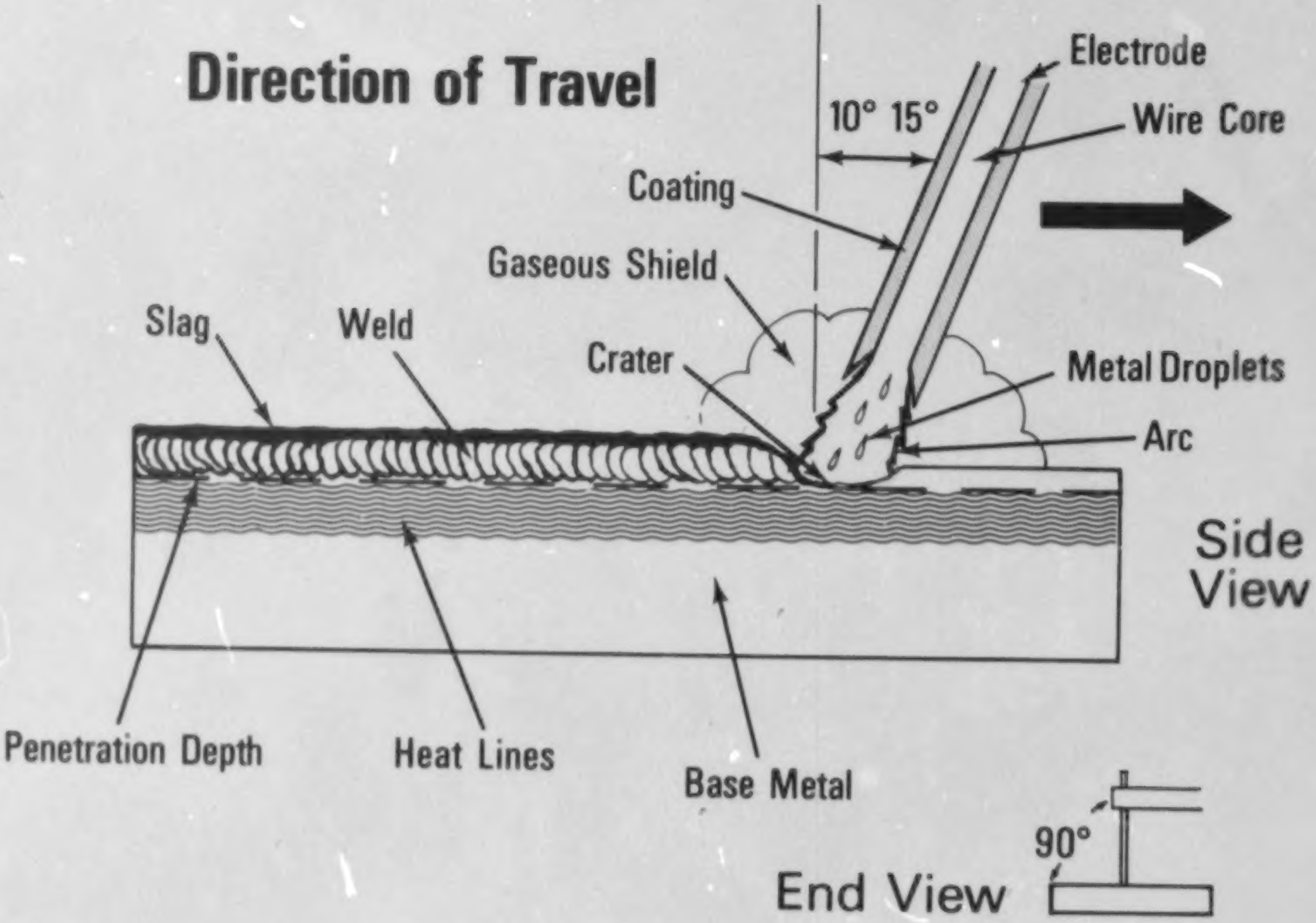
T



Lap



Direction of Travel


10° 15°
Electrode
Wire Core
Coating
Gaseous Shield
Slag
Weld
Crater
Metal Droplets
Arc
Side View
Penetration Depth
Heat Lines
Base Metal
90°
End View

SHIELDED METAL ARC WELDING
UNIT IV

JOB SHEET #1--START, STOP, AND RESTART THE ARC

I. Equipment and materials

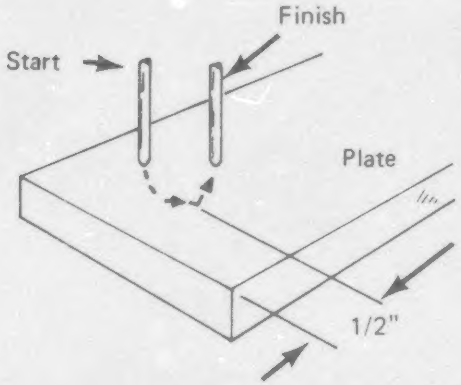
- A. Metal--1/4" to 3/8", 4" x 4"
- B. Welding machine and accessories
- C. Welding helmet
- D. Protective clothing
- E. E-6010 electrode--1/8" or 5/32"
    - 1. 1/8" - 75-130 amps
    - 2. 5/32" - 90-175 amps
- F. Current DCRP (+) at the electrode
- G. Chipping hammer
- H. Wire brush

II. Procedures

- A. Starting a bead
    - 1. Adjust machine to desired welding current

      (NOTE: This desired current will depend on type and size of electrode and thickness of metal. Refer to Chart #1.)
    - 2. Hold electrode perpendicular to work where weld is to start (Figure 1)

FIGURE 1



JOB SHEET #1

3. Slant electrode 10° to 15° in direction of travel

4. Lower electrode and tap or scratch lightly on edge of plate

   (NOTE: This procedure is necessary for establishing an arc.)

5. Momentarily raise electrode upon establishment of arc

   (NOTE: This preheats the edge of metal and prevents a cold start.)

6. Lower electrode to correct arc length

7. Rotate electrode

   (NOTE: Do this to build up desired height of bead and to obtain desired width of bead. When desired crater develops, move out slowly using normal manipulation.)

B. Stopping bead

1. Return electrode to 90° or perpendicular to work

2. Reverse electrode and hold until crater fills

   (NOTE: This causes crater build up, removes impurities from weld, and prevents crater from cracking.)

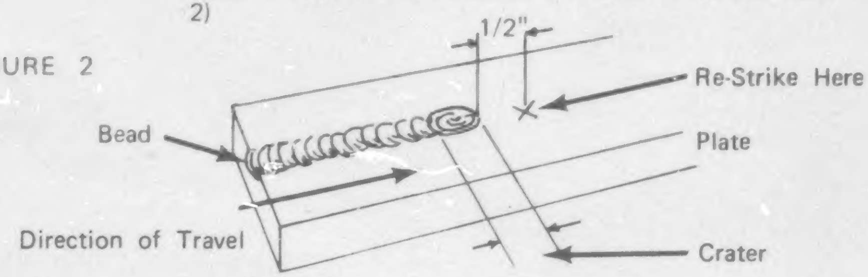
3. Raise electrode quickly when desired width and height of bead is formed

C. Restarting a bead

1. Start arc about 1/2" to 3/4" in front of crater

2. With a long arc, move electrode back to within 1/16" of the crater crown, fill to bead size then resume normal travel (Figure 2)

FIGURE 2



3. Fuse new crater into last ripple of crater

4. Maintain correct width of bead while completing weld

   (NOTE: Arc length is correct when it makes a "frying" noise. The force of the arc determines penetration and bead appearance.)

SHIELDED METAL ARC WELDING
UNIT IV

JOB SHEET #2--MAKE A PAD IN THE FLAT POSITION

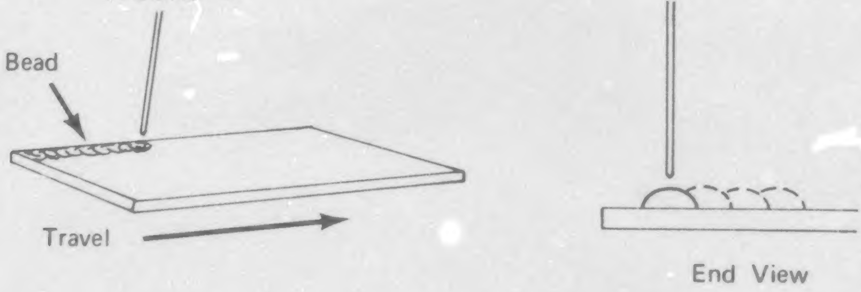
I. Equipment and materials
   A. Mild steel metal 3/8" thick, 6" by 6"
   B. Welding machine and accessories
   C. Welding helmet
   D. Protective clothing
   E. E-6010 electrodes--1/8" or 5/32"
      1. 1/8" - 75-130 amps
      2. 5/32" - 90-175 amps
   F. Current DCRP (+) at the electrode
   G. Chipping hammer
   H. Wire brush
   I. Pliers or vise grips

II. Procedures
   A. Set welding machine
   B. Prepare and place metal in flat position

      (NOTE: Remove all dirt, grease, and mill scale from surfaces of metal.)

   C. Run a straight bead near edge of plate (Figure 1)

FIGURE 1



(NOTE: For the first bead, the electrode should be held almost vertical. NO side angle.)

(CAUTION: Avoid burning off edge of plate.)

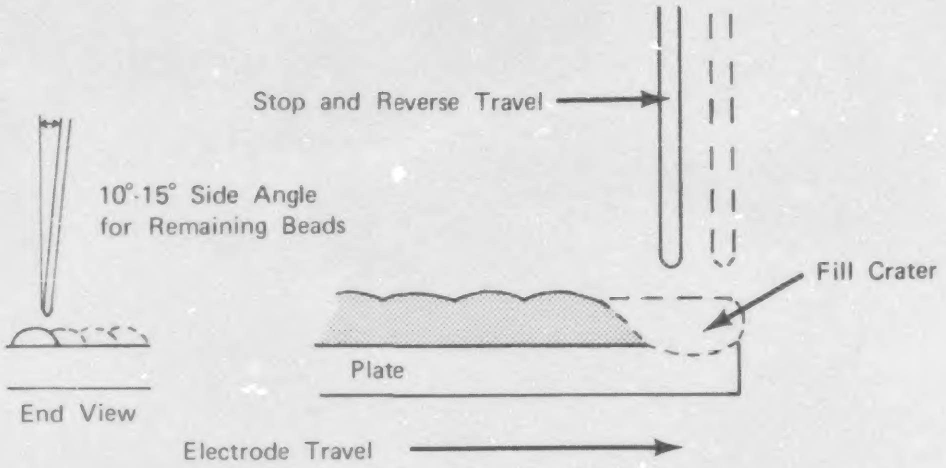
JOB SHEET #2

D. After laying first bead, chip and brush it clean and check surface

(NOTE: The surface appearance should be smooth and even. Check for pinholes, crater holes, slag holes, or indications of improper starts and stops. Also, checking the bead will identify if current needs to be changed.)

E. Reverse travel and run additional beads, remember to overlap at least the first one-third of the previous bead (Figure 2)

FIGURE 2


Stop and Reverse Travel
10°-15° Side Angle
for Remaining Beads
Fill Crater
Plate
End View
Electrode Travel

(NOTE: The electrode should be held at 10° to 15° to the side for this bead and all other beads.)

F. Clean each pass thoroughly before overlapping with another

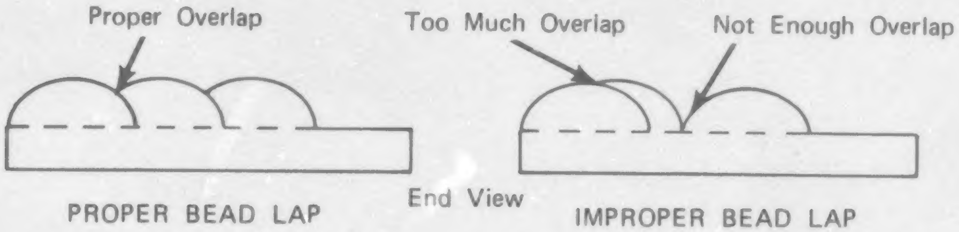
(NOTE: This will insure a sound deposit with proper penetration and no slag holes.)

JOB SHEET #2

G. Fuse each pass with base metal as well as with the preceding pass (Figure 3)

(NOTE: Alternate travel directions for each pass.)

FIGURE 3



PROPER BEAD LAP

Beads should not over or underlap each other. Note approximate 1/3 overlap.

IMPROPER BEAD LAP

Excessive overlap makes the bead too high crowned. Not enough overlap makes a V-shaped depression Slag may be trapped in this area.

(NOTE: The overlapping beads should produce a comparatively smooth surface without noticeable "valleys" between passes.)

H. Continue running beads until pad is full

I. Clean the piece of metal thoroughly and turn in to the instructor for grading

SHIELDED METAL ARC WELDING
UNIT IV

JOB SHEET #3--MAKE A SQUARE GROOVE BUTT WELD

I. Equipment and materials

  A. Two pieces of metal 3/16" to 1/4" thick, 2" wide, and 6" long

  B. Welding machines and accessories

  C. Welding helmet

  D. Protective clothing

  E. E-6010--1/8" or 5/32"

    1. 1/8" - 75-130 amps

    2. 5/32" - 90-175 amps

  F. Current DCRP (+) at the electrode

  G. Safety goggles

  H. Chipping hammer

  I. Wire brush

II. Procedures

  A. Adjust welding machine to correct welding current

  (NOTE: Refer to Chart #1.)

  B. Prepare metal for welding by removing dirt, grease, or mill scale

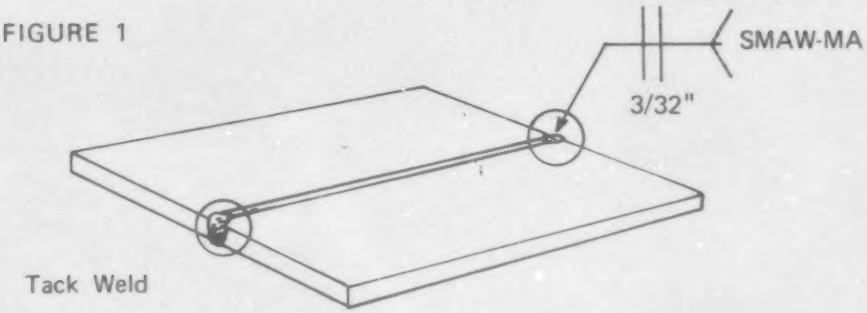
  C. Place metal together parallel to each other, leaving a space 3/32"

  (NOTE: The proper space can be determined by placing the bare end of a 3/32" electrode between the two pieces of metal.)

JOB SHEET #3

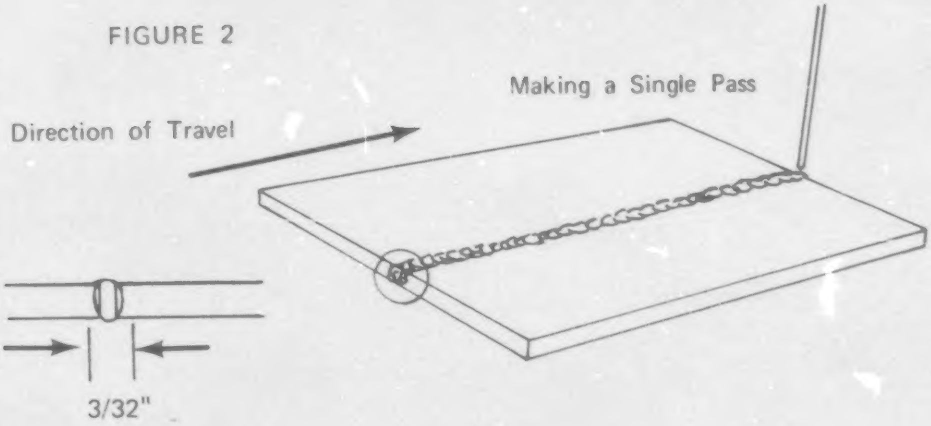
D. Tack weld pieces together at both ends (Figure 1)

FIGURE 1


SMAW-MA
3/32"
Tack Weld

E. Weld pieces together using a single pass on one side for 100% penetration (Figure 2)

FIGURE 2


Making a Single Pass
Direction of Travel
3/32"

F. Chip slag, brush weld, and check for complete penetration at the root of weld

SHIELDED METAL ARC WELDING
UNIT IV

TEST

1. Match the terms on the right with the correct definition.

______a. Exposed surface of a weld, made by an arc or gas welding process on the side from which welding was done

______b. Arc welding process wherein metals are united by heating with an electric arc between a coated metal electrode and the metal

______c. Depression at the termination of a weld

______d. Flow of electric current from the tip of the electrode to the base of the metal being welded

______e. Distance from the end of the electrode to the point where the arc makes contact with work surface

______f. Metal rod which conducts a current from the electrode holder to the base metal

______g. The metal to be welded or cut

______h. Fusible material or gas used to dissolve and/or prevent the formation of oxides, nitrides, or other undesirable inclusions formed in welding

______i. That portion of a weld that is molten at the place the heat is supplied

______j. Weld made to hold parts in proper alignment until the final welds are made

______k. Steel containing .20% or less carbon

1. Whipping
2. Shielded metal arc welding
3. Weld metal
4. Arc
5. Weaving
6. Electrode
7. Undercut
8. Base metal
9. Puddle
10. Arc length
11. Tack weld
12. Crater
13. Spatter
14. Face of weld
15. Porosity
16. Flux
17. Pass
18. Low carbon steel
19. AWS
20. Disposition rate

______l. Metal particles given off during welding which do not form a part of the weld

______m. Single longitudinal progression of a welding operation along a joint or weld deposit

______n. Gas pockets or voids in metal

______o. Term applied to an inward and upward movement of the electrode which is employed in vertical welding to avoid undercut

______p. Groove melted into the base metal adjacent to the toe of the weld and left unfilled by weld metal

______q. That portion of a weld which has been melted during welding

______r. Technique of depositing weld metal in which the electrode is oscillated

______s. American Welding Society

______t. Amount of filler metal deposited in any welding process; rate is in pounds per hour

2. Name four types of arc welding machines.

a.

b.

c.

d.

3. Name the common equipment needed in shielded metal arc welding.

a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

k.

4. Distinguish between straight and reverse polarity by placing an "X" before the statement that signifies reverse polarity.

_____a. Current flows from electrode to base metal

_____b. Current flows from base metal to electrode

5. Select from the list below factors that determine the polarity to use in shielded metal arc welding by placing an "X" in the blanks provided.

_____a. Type of flux on electrode

_____b. Electrode

_____c. Current

_____d. Brand of welding machine

6. Name the two types of operating adjustments found on arc welding machines.

a.

b.

7. Discuss in a short paragraph the procedure to follow in testing for polarity.

8. Name four common types of electrodes.

   a.

   b.

   c.

   d.

9. Name four common sizes of electrodes.

   a.

   b.

   c.

   d.

10. Select from the list below the factor that determines electrode size by placing an "X" in the blank provided.

    ______a. Length of electrode

    ______b. Diameter of bare end of electrode

    ______c. Type of flux on electrode

11. Select from the list below the purposes of flux coating on electrodes by placing an "X" in the blanks provided.

    ______a. Stabilizes arc

    ______b. Makes arc starting difficult

    ______c. Shields molten puddle from air

    ______d. Provides deoxidizers and scavengers to prevent porosity of weld zone

    ______e. Keeps moisture out of filler metal

    ______f. Forms slag and slows cooling

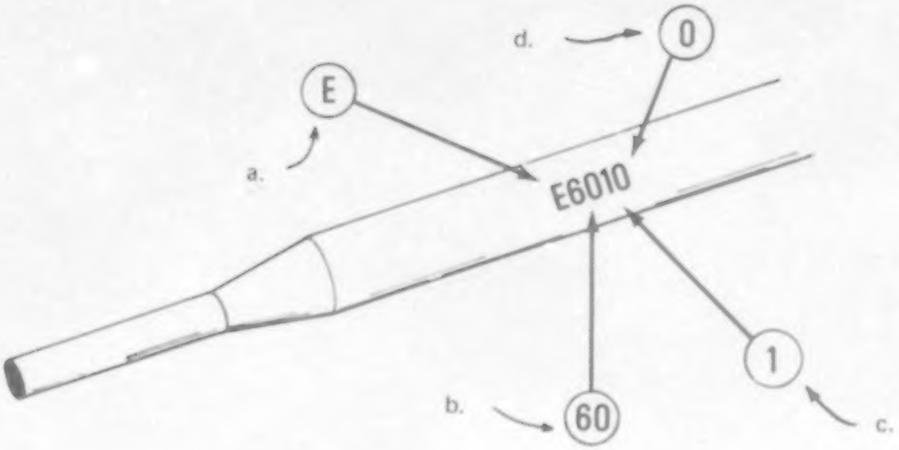
12. Identify the parts of the drawing below.

a.

b.

c.

d.



13. Name five factors to be considered when selecting an electrode for a specific job application.

a.

b.

c.

d.

e.

14. Name four types of welds.

a.

b.

c.

d.

15. Identify the parts of groove and fillet welds in the drawings below.

a.

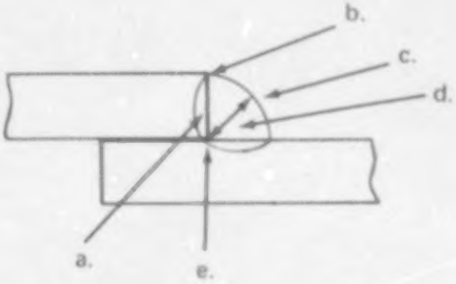
b.

c.

d.

e.

f. Type of weld



g.

h.

i.

j.

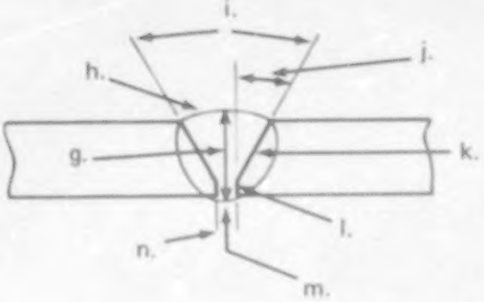
k.

l.

m.

n.

o. Type of weld



16. Identify the types of weld joints.

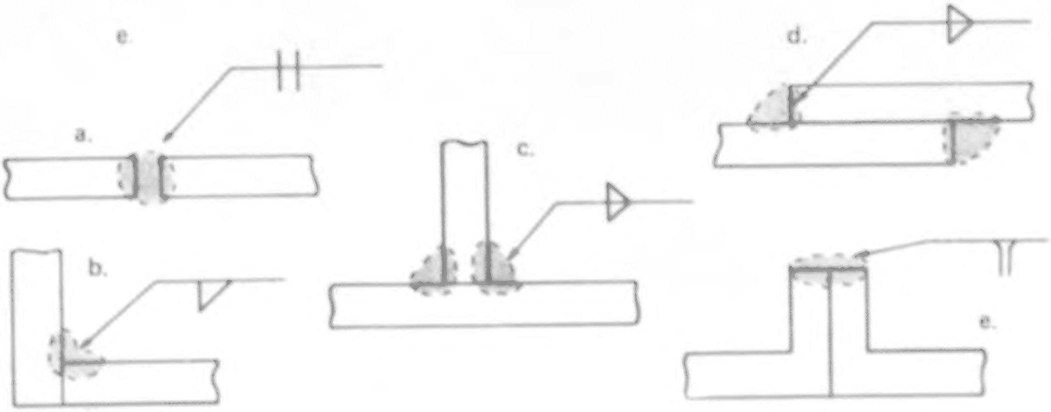
a.

b.

c.

d.

e.



17. Select from the list below reasons for poor welds by placing an "X" in the blanks provided.

_____a. Improper angle of electrode

_____b. Improper electrode length and size

_____c. Improper machine adjustment

_____d. Improper clamping of electrode in holder

_____e. Welding from left to right with the forehand technique

_____f. Improper base metal preparation

_____g. Running a E-6010 electrode on DCRP

_____h. Improper arc length

18. Identify the parts of the welding process illustrated below.

a.

b.

c.

d.

e.

f.

g.

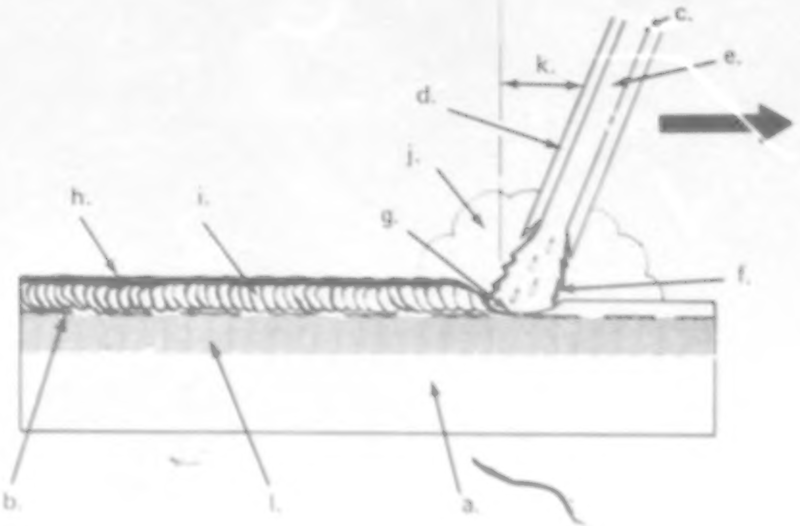
h.

i.

j.

k.

l.



19. Name the two methods of striking an arc.

a.

b.

20. Name five safety precautions to follow in shielded metal arc welding.

a.

b.

c.

d.

e.

21. Match the lens shade number on the right to the type of welding operation. Some of the numbers may be used more than once.

_____a. Gas welding using metal 0 - 1/8 inch thick

_____b. Soldering

_____c. Torch brazing

_____d. Shielded metal arc welding using 1/16, 3/32, 1/8, and 5/32 inch electrodes

_____e. Gas tungsten arc welding nonferrous

_____f. Oxygen cutting using metal 6" and over

1. No. 2
2. No. 3 or 4
3. No. 4 or 5
4. No. 5 or 6
5. No. 6 or 8
6. No. 9 - 14

22. Demonstrate the ability to perform the following tasks:

a. Start, stop, and restart a bead.

b. Strike an arc and construct a pad in flat position, using E-6010 rod, by running uniform beads on mild steel plate which is one-fourth inch to three-eighths inch thick.

c. Construct a square groove butt weld on three-sixteenths or one-fourth inch steel plate with one-hundred percent penetration, using a single pass with E-6010 rod.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

SHIELDED METAL ARC WELDING
UNIT IV

ANSWERS TO TEST

1. a. 14
   b. 2
   c. 12
   d. 4
   e. 10
   f. 6
   g. 8
   h. 16
   i. 9
   j. 11
   k. 18
   l. 13
   m. 17
   n. 15
   o. 1
   p. 7
   q. 3
   r. 5
   s. 19
   t. 20

2. a. AC transformer welder
   b. AC-DC transformer rectifier
   c. Motor generator
   d. Engine generator

3. a. Welding machine
   b. Electrode holder with lead
   c. Ground clamp with lead
   d. Shield or helmet
   e. Gloves
   f. Chipping hammer
   g. Safety goggles
   h. Wire brush
   i. Electrodes
   j. Pliers
   k. Protective clothing

4. b

5. a and b

6. a. Current (amperage) settings

   b. Polarity

7. The discussion should bring out the two main methods.

   a. Weld a bead using E-6010 reverse polarity electrode

   b. Strike arc with carbon electrode

8. Any four of the following

   a. Mild steel

   b. Low hydrogen--low alloy

   c. Nonferrous

   d. Hard surfacing

   e. Cast iron

   f. Stainless steel

9. Any four of the following:

   a. 3/32"

   b. 1/8"

   c. 5/32"

   d. 3/16"

   e. 7/32"

   f. 1/4"

   g. 5/16"

10. b

11. a, c, d, f

12. a. Electrode

    b. Tensile strength deposited in a thousand pounds per square inch

   c. Welding position
      1) All positions
      2) Flat and horizontal
   d. Special characteristics and usability of the rod
      1) Current
      2) Penetration
      3) Type of flux coating

13. Any five of the following:
   a. Base metal strength properties
   b. Base metal composition
   c. Welding position
   d. Welding current
   e. Joint design and fit-up
   f. Thickness and shape of base metal
   g. Service conditions and/or specification
   h. Production efficiency and job conditions

14. a. Bead
   b. Fillet
   c. Groove
   d. Plug

15. a. Leg
   b. Toe
   c. Face
   d. Throat
   e. Root
   f. Fillet
   g. Throat

h. Face
i. Groove angle
j. Bevel angle
k. Groove face
l. Root face
m. Root
n. Root opening
o. Groove
16. a. Butt
b. Corner
c. T
d. Lap
e. Edge
17. a, b, c, f, h
18. a. Base metal
b. Penetration
c. Electrode
d. Coating
e. Wire core
f. Arc
g. Crater
h. Slag
i. Weld
j. Gaseous shield
k. 10° to 15°
l. Heat lines
19. a. Tapping
b. Scratching

20. Any five of the following:

    a. Keep equipment in good, clean, dry condition

    b. Make sure all electrical connections are tight, clean, and dry

    c. Use correct size welding cable; do not overload

    d. Be sure cables, holder, and connections are properly insulated

    e. Cut off power to welder before cleaning machine or making internal adjustments

    f. Never change polarity or current settings while machine is under load

    g. Observe normal operating care for electrical hazards

    h. Keep work area neat, clean, and dry

    i. Remove flammable materials from welding area, or shield them

    j. Do not weld near volatile, flammable liquids or gases

    k. Do not weld or cut on containers such as drums, barrels, or tanks until you know there is no danger of fire or explosion

    l. Dispose of hot electrode stubs in a metal container

    m. Never strike an arc on a compressed gas cylinder

    n. Protect your eyes from rays of the arc; wear a headshield with the proper filter plates when welding or cutting

    o. Wear protective chipping goggles when chipping off weld slag

    p. Wear leather gloves and protective clothing such as an apron, sleeves, etc. to shield against the arc rays and sparks; button up shirt collar

    q. Use a nonreflecting welding curtain to protect others in the area from the arc rays

    r. Be sure work area has adequate ventilation with plenty of fresh air; special precautions are necessary when welding lead, zinc, beryllium copper, or cadmium

    s. Do not pick up hot metal

    t. Always open main switch or disconnect plug when checking over a welder

    u. Do not leave electrode holder on welding table or in contact with grounded metal surface

    v. Keep tools and metal in their proper locations

21. a. 3
    b. 1
    c. 2
    d. 6
    e. 6
    f. 4

22. Performance skills will be evaluated according to the criteria listed on the progress chart.

GAS METAL ARC WELDING
UNIT V

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms associated with gas metal arc welding to the correct definition. He should be able to name the advantages of the GMAW process and set up and shut down the GMAW equipment for the four major applications of the process. He should be able to identify power sources, welding wires, and shielding gases used in this process and be able to perform the jobs outlined in this unit. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the GMAW process to the correct definition.
2. List six advantages of the GMAW process.
3. Identify the major parts of the GMAW equipment.
4. Select from a list three applications of the GMAW process.
5. List factors to be considered when selecting a filler wire for the GMAW process.
6. Name the two types of mild steel welding wires used in GMAW welding.
7. Match the shielding gases to their use.
8. Identify the causes of poor welds.
9. List the characteristics of a good weld.
10. Name the two types of power sources for GMAW.
11. Describe the effects of electrode wire stick out on volts and amps.
12. Demonstrate the ability to:
    a. Set up and shut down the GMAW equipment for short arc, spray arc, and flux cored arc welding applications.
    b. Construct a multiple pass T-joint fillet weld on mild steel in the horizontal position with short arc.
    c. Construct a lap joint fillet weld on mild steel in the vertical down position with short arc.

d. Construct a square groove butt joint on mild steel in the flat position with short arc.

e. Construct a square groove butt joint on mild steel in the horizontal position with short arc.

GAS METAL ARC WELDING
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Discuss terminal and specific objectives.

   D. Discuss information sheet.

   E. Demonstrate and discuss procedures outlined in the job sheets.

   F. Give test.

II. Students:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1--GMAW Equipment

      2. TM 2--GMAW Process

      3. TM 3--Weld Quality Inspection--Common Welding Mistakes

      4. TM 4--Weld Quality Inspection--Good Welds

      5. TM 5--GMAW Electric Wire Stick Out

      6. TM 6--Arc Length/Arc Volt-Amp Characteristics

D. Job sheets

1. Job Sheet #1--Set Up and Shut Down GMAW Equipment
2. Job Sheet #2--Construct a Multiple Pass T-Joint Fillet Weld in the Horizontal Position
3. Job Sheet #3--Construct a Lap Joint Fillet Weld in the Vertical Down Position
4. Job Sheet #4--Construct a Square Groove Butt Joint in the Flat Position With Short Arc
5. Job Sheet #5--Construct a Square Groove Butt Joint in the Horizontal Position With Short Arc

E. Test

F. Answers to test

II. References:

A. *American Welding Society Specifications on GMAW Wire Number A 5.18 and A 5.20.* American Welding Society, 2501 N. 7th Street, Miami, Florida.

B. Ahella, F.J. and R.P. Sullivan. *Gas Metal-Arc Welding of Stainless Steel Using Short-Circuiting Transfer.* Newark, New Jersey: Linde Division, Union Carbide Corp.

C. *Hobart Welding School Workbook.* Hobart School of Welding Technology, Troy, Ohio.

D. *How To Do Manual Metal Inert Gas Welding.* Newark, New Jersey: Linde Division, Union Carbide Corp.

E. Jefferson, T.B. and Gorham Woods. *Metals and How to Weld Them.* Cleveland, Ohio: James F. Lincoln Arc Welding Foundation.

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K. *Fusion Welding Aluminum*. Richmond, Virginia: Reynolds Aluminum Company.

L. *Micro-Wire Welding*. Troy, Ohio: Brothers Technical Center.

M. *Hobart Welding Guide and Welding Lessons*. Troy, Ohio: Hobart Welding School.

N. *Fabco Welding*. Troy, Ohio: Hobart Brothers Technical Center.

GAS METAL ARC WELDING
UNIT V

INFORMATION SHEET

I. Terms and definitions

A. Gas metal arc welding (GMAW)--Arc welding process in which a consumable base electrode is fed into a weld joint at a controlled rate while a continuous blanket of gas, inert or otherwise, shields the weld zone from contamination by the atmosphere (Transparencies 1 and 2)

(NOTE: Gas metal arc welding is sometimes called MIG welding.)

B. FCAW--Abbreviation for flux cored arc welding; a form of GMAW performed with a cored consumable electrode (flux inside the wire)

C. Short circuiting transfer (short arc)--Welding application of the GMAW process where low currents, low voltages, and small diameter wires are used to weld on thin to heavy metal in all positions

D. Welding current (amperage)--Will usually be direct current reverse polarity (DCRP) with the welding wire positive (+) and the work negative (-)

E. Welding voltage (arc length)--Heat generated by the flow of current through the gap between the end of the wire and the workpiece; voltage appears across this gap and varies in the same direction as the length of the arc

F. Slope--The slant of the volts versus amps curve, generally referred to as volts change per 100 amps

G. Slope control--A control on the power supply that regulates the amount of pinch force available on welding wire, thereby controlling spatter or the pinch effect

H. Inductance--Controls the rate of rise of current without controlling the final amount of current available

(NOTE: In short arc welding, the inductance control will increase or decrease the number of short circuit metal transfers per second, from 20-200 times per second with an average of 100 times per second, increasing or decreasing the arc on time, thereby making the weld puddle more or less fluid.)

I. Stick out--Distance from the contact tip of the gun to the end of the electrode

INFORMATION SHEET

J. Whiskers--Short lengths of welding wire that feed through the root gap of a grooved joint and extend out from the root of the weld in all directions

K. Open circuit voltage--Voltage indicated by volt meter on GMAW power supply when machine is running but not welding

L. Arc voltage--Voltage indicated by a volt meter on GMAW power supply when machine is welding

M. Ferrous--Any metal containing iron such as mild steel or stainless steel

N. Nonferrous--Any metal that contains no iron such as aluminum or magnesium

O. Shielding gases--Gases, inert or otherwise, used to displace the air around the arc to prevent contamination by oxygen, nitrogen, or hydrogen from the atmosphere

II. Advantages of the GMAW process

A. Arc always visible to the welder

B. No slag and a minimum amount of spatter

C. High disposition rate with 95% of the welding wire deposited in the joint

D. Weld metal deposit of low hydrogen quality

E. Wide range of metal thicknesses can be welded without changing wire

F. Excellent for bridging gaps or misaligned joints without burn-through

G. Greatly reduced distortion in gage metal

H. Adaptable to weld most any metal by the selection of correct filler wire and shielding gases

I. Adaptable to either automatic or semiautomatic

III. Major parts of GMAW equipment (Transparency 1)

A. Power supply

B. Voltage control

C. Welding terminals

D. Power on-off switch

INFORMATION SHEET

E. Volt meter

F. Amp meter

G. Wire feed control system

H. Feed rolls

I. Wire feed control (amperage)

J. Wire reel or coil

K. Gun

L. Shielding gas

M. Flowmeter

IV. Applications of GMAW process

A. Short circuiting (short arc)--Employs low currents, low voltage, and small diameter wires

(NOTE: The short arc process is the most popular of the GMAW processes.)

B. Spray arc--Uses high current, high voltages, and large diameter wires on thicker metals

C. Flux cored wire--Designed primarily for welding steel

(NOTE: Some self-shielded (gasless) flux cored and solid wire applications utilize DCSP rather than DCRP.)

V. Factors to consider in selecting filler wire

A. Metal to be welded

B. Metal thickness and joint design

C. Metal surface condition

D. Specifications of the job

VI. Welding wires

A. Solid

(NOTE: Standard sizes of solid wire are: .035", .045", 1/16", 5/64", 3/32", and 1/8".)

INFORMATION SHEET

- B. Flux cored

  (NOTE: Standard wire sizes are: 1/16", 5/64", 3/32", 7/64", 1/8", and 5/32".)

VII. Shielding gases and their uses

- A. Argon--Used to weld aluminum and magnesium
- B. Argon-Helium--Used to weld heavy sections of aluminum
- C. Argon-Co_2--Used to weld mild and stainless steels

  (NOTE: One of the more popular mixtures for short arc is 75% Argon and 25% Co_2. This mixture is known as C-25.)

- D. Helium-Argon-Co_2--Used for mild and stainless steels

  (NOTE: Another one of the more popular mixes used in short arc welding contains 90% Helium, 7.5% Argon, and 2.5% Co_2.)

- E. Co_2--Used for mild steel with short arc and flux cored application
- F. Argon-Oxygen--Used for mild, stainless, and alloy steels and copper alloys

  (NOTE: The nature of shielding gases require that GMAW be done where there is no excessive wind or drafts to displace the gas that results in brittle, porous welds.)

VIII. Common weld mistakes (Transparency 3)

- A. Cold lapping (incomplete fusion)
- B. Excessive penetration
- C. Insufficient penetration
- D. Burn-through
- E. Surface porosity
- F. Poor appearance
- G. Whiskers
- H. Bad tie-in
- I. Suck-back (internal concavity)

INFORMATION SHEET

IX. Characteristics of a good weld (Transparency 4)

   A. Even ripple on bead

   B. Slight crown (convex) at root

   C. Well fused throughout joint

X. Types of power sources

   A. Transformer-rectifier

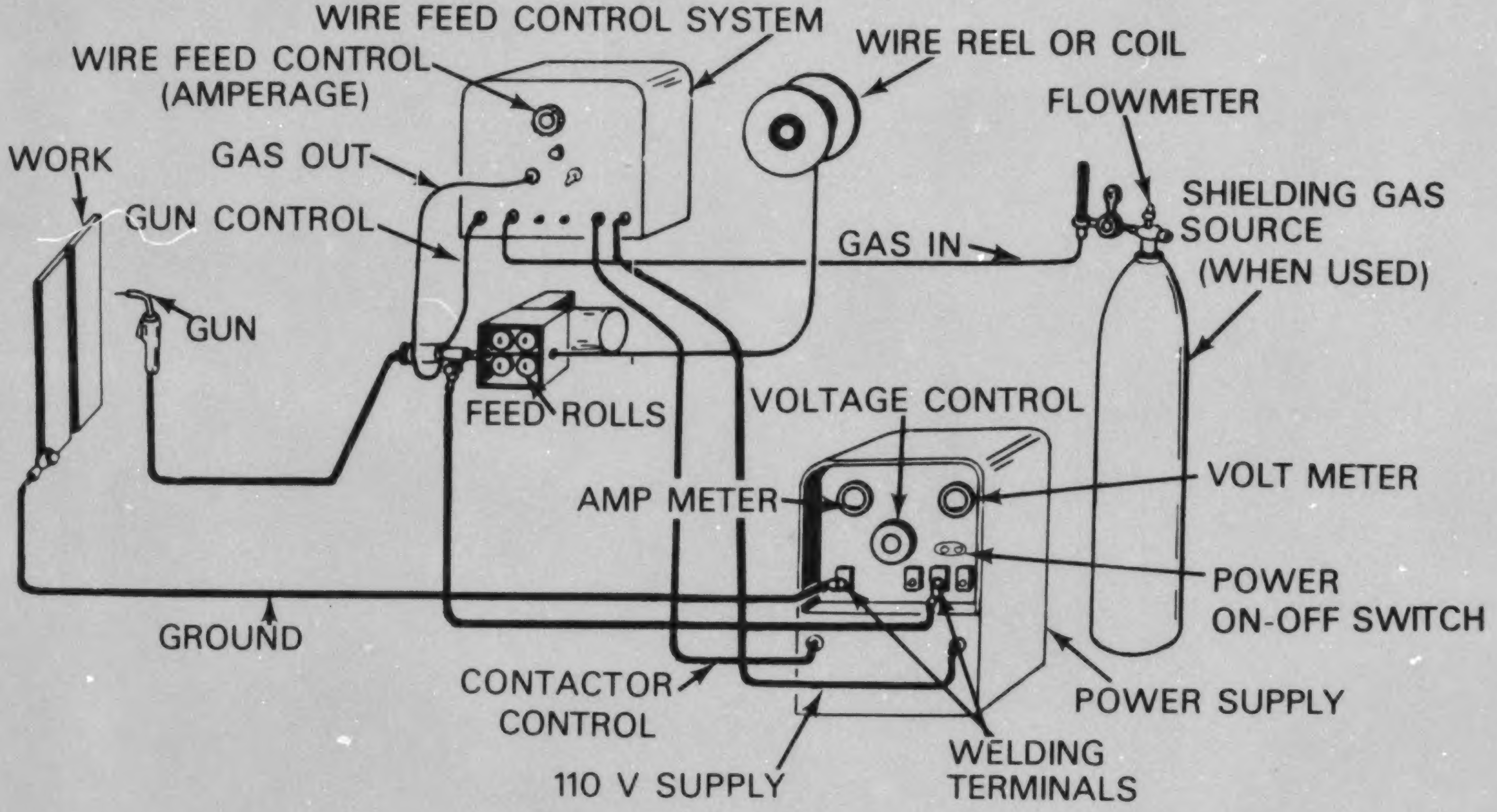
   B. Engine or motor generator

XI. Effects of electrode wire stick out on volts and amps (Transparencies 5 and 6)

   A. Increased stick out (long arc)--Increases arc volts and decreases amps

   B. Short stick out (short arc)--Increases amps and decreases arc volts

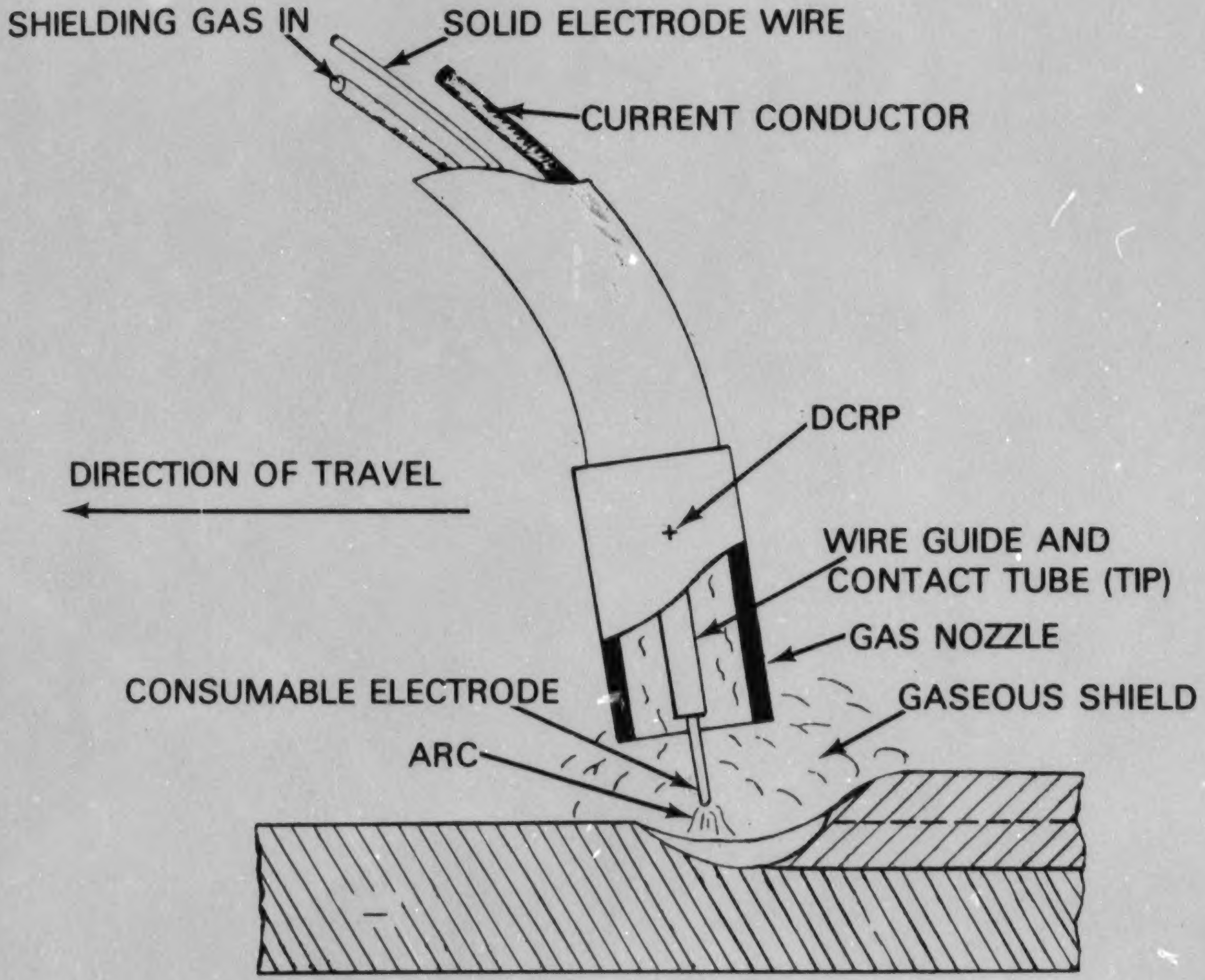
GMAW Equipment


WIRE FEED CONTROL SYSTEM
WIRE REEL OR COIL
WIRE FEED CONTROL (AMPERAGE)
FLOWMETER
WORK
GAS OUT
SHIELDING GAS SOURCE (WHEN USED)
GUN CONTROL
GAS IN
GUN
FEED ROLLS
VOLTAGE CONTROL
VOLT METER
AMP METER
POWER ON-OFF SWITCH
GROUND
CONTACTOR CONTROL
POWER SUPPLY
WELDING TERMINALS
110 V SUPPLY

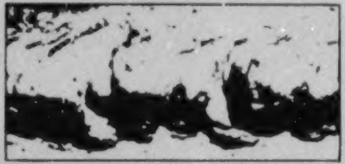
*DCRP-Most GTAW Applications

(NOTE: Some Flux Cored GTAW Is Done With DCSP.)

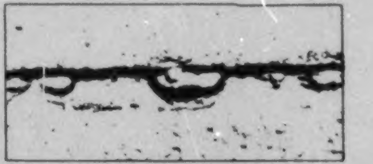
GMAW Process


SHIELDING GAS IN
SOLID ELECTRODE WIRE
CURRENT CONDUCTOR
DCRP
+
DIRECTION OF TRAVEL
WIRE GUIDE AND CONTACT TUBE (TIP)
GAS NOZZLE
CONSUMABLE ELECTRODE
GASEOUS SHIELD
ARC
–

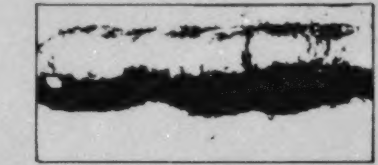
Weld Quality Inspection--Common Welding Mistakes



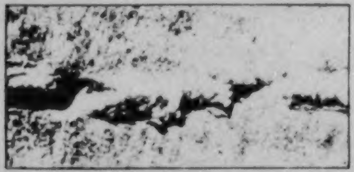
POOR APPEARANCE



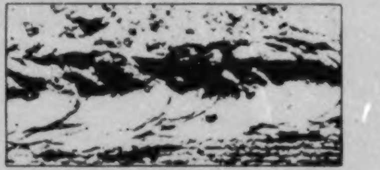
INSUFFICIENT PENETRATION



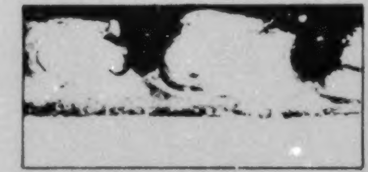
EXCESSIVE PENETRATION



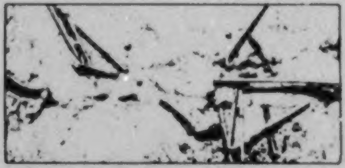
BAD TIE-IN



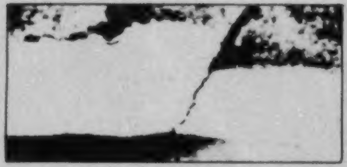
SUCK-BACK



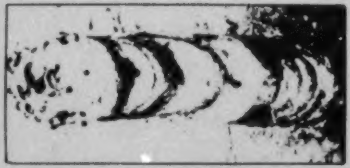
BURN-THROUGH



WHISKERS

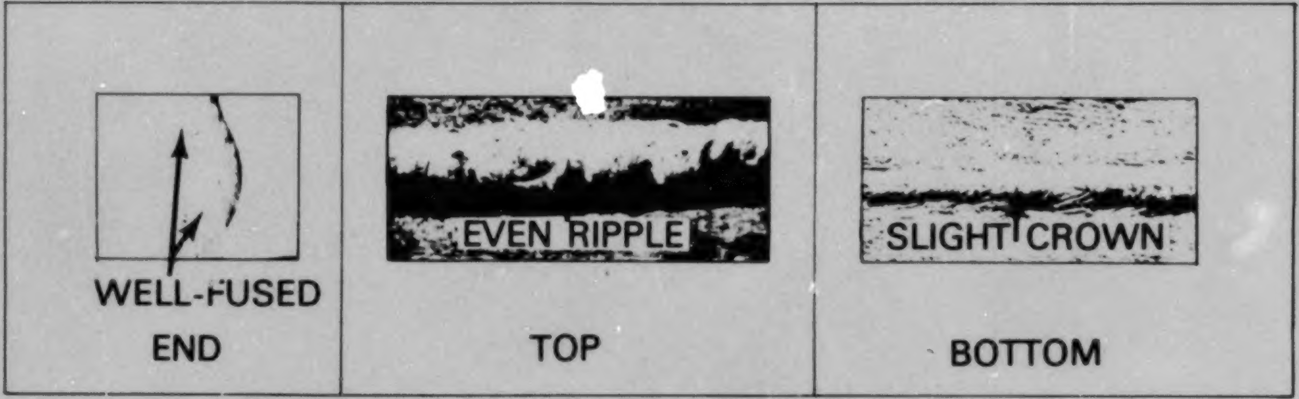


COLD LAPPING

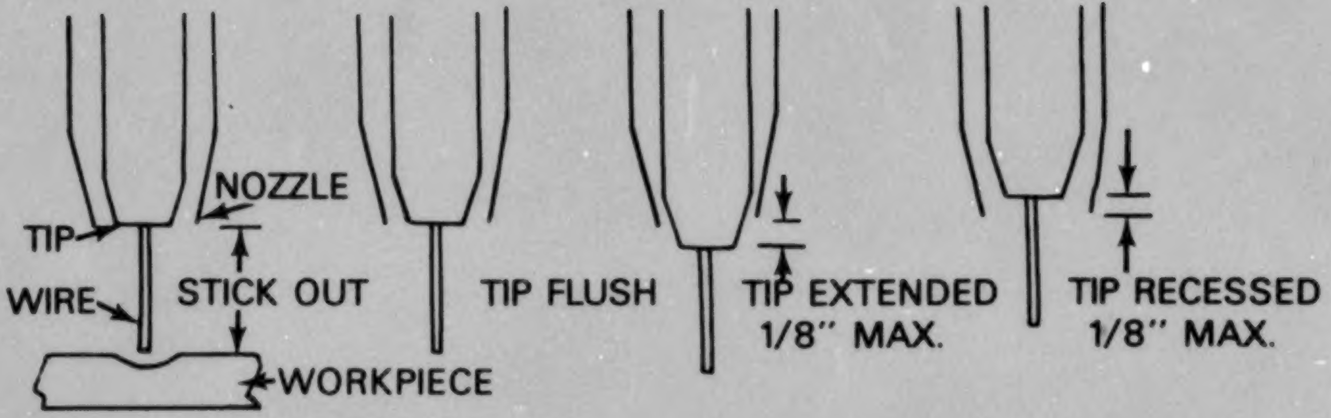


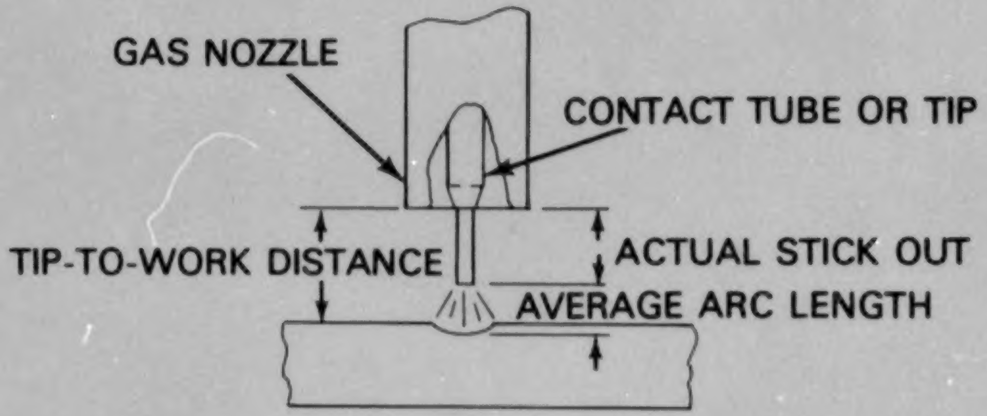
SURFACE POROSITY

Weld Quality Inspection--Good Welds


WELL-FUSED
END
EVEN RIPPLE
TOP
SLIGHT CROWN
BOTTOM

GMAW Electric Wire Stick Out

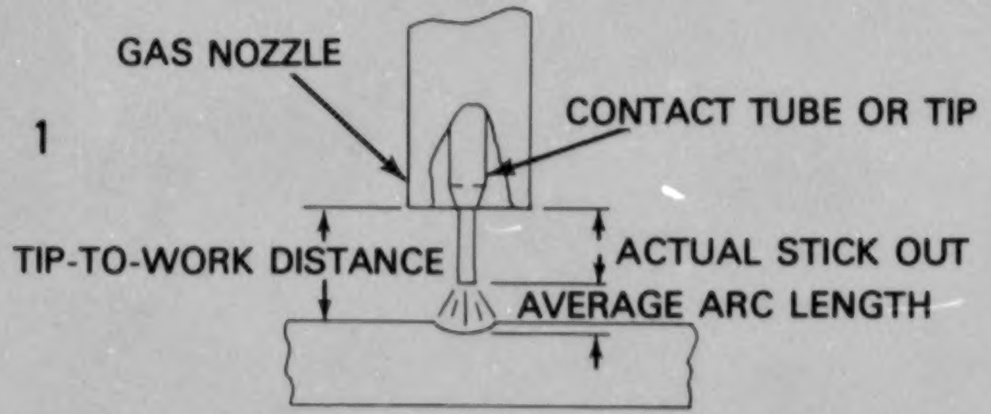

NOZZLE
TIP
WIRE
STICK OUT
WORKPIECE
TIP FLUSH
TIP EXTENDED
1/8" MAX.
TIP RECESSED
1/8" MAX.


GAS NOZZLE
CONTACT TUBE OR TIP
TIP-TO-WORK DISTANCE
ACTUAL STICK OUT
AVERAGE ARC LENGTH

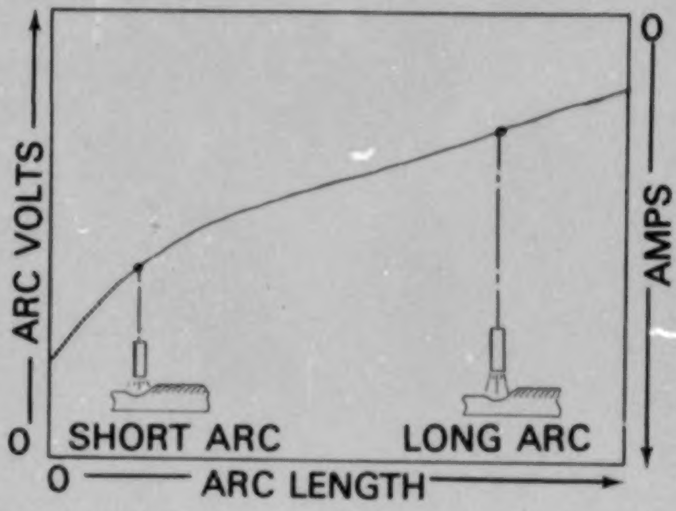
(STICK OUT IS TIP-TO-WORK)

Arc Length Arc Volt-Amp Characteristics

1


GAS NOZZLE
CONTACT TUBE OR TIP
TIP-TO-WORK DISTANCE
ACTUAL STICK OUT
AVERAGE ARC LENGTH

2



1 SMALL CHANGE IN ARC VOLTS (ARC LENGTH CHANGED BY WELDER'S MOVEMENT OF GUN) RESULTS IN LARGE CHANGE OF WELDING CURRENT (AMPS)

2 SHORT ARC LENGTH = INCREASE AMPS = DECREASE ARC VOLTS
LONG ARC LENGTH = INCREASE ARC VOLTS = DECREASE AMPS

GAS METAL ARC WELDING
UNIT V

JOB SHEET #1--SET UP AND SHUT DOWN GMAW EQUIPMENT

I. Equipment and materials needed

  A. GMAW power supply, feeder wire, and gun (air-cooled)

  B. Shielding gas

    1. For mild steel--Co_2; C-25

    2. For stainless steel--Argon, C-25; Helium-Argon-Co_2; Argon-Oxygen (1-5%)

    3. For aluminum, copper, magnesium--Argon, Helium, or Argon-Helium mixes

  (NOTE: Flux cored welding is for steel only with or without shielding gas.)

  C. Electrode filler wire

    1. Solid or cored--Determined by base metal to be welded

    2. Wire diameters

      a. Short arc--.030", .035", .045"

      b. Spray arc--.045", 1/16", 3/64", 3/32"

      c. Flux cored--.045", 1/16", .68", 5/64", 3/32", 7/64", 1/8", 5/32"

  D. Current settings

    1. Short arc--DCRP--50-250 amps

    2. Spray arc--DCRP--250-450 amps

    3. Flux cored--DCRP--120-650 amps; DCSP--120-650 amps

  E. Voltage setting

    1. Short arc--12-30 arc volts

    2. Spray arc--24-36 arc volts

    3. Flux cored--20-38 arc volts

JOB SHEET #1

II. Set up procedure

- A. Set up power supply controls as follows
    - 1. Start welding machine--Push start switch or start engine if engine driven
    - 2. Set machine controls
        - a. Voltage
        - b. Inductance (if equipped)
        - c. Slope (if equipped)
- B. Set up wire pad and shielding gas controls
    - 1. Set up wire feed
        - a. Correct size and type of wire
        - b. Correct size feed roll or rolls
        - c. Inch wire out to gun using incher control if equipped
        - d. Adjust tension on feed rolls

          (NOTE: Tension should be tight enough to feed wire but should not deform or mark wire.)
        - e. Turn on power switch
    - 2. Set up and adjust shielding gas controls (if used)
        - a. Blow out cylinder valve to remove any dirt or foreign material
        - b. Mount gas flowmeter to cylinder in a vertical position
        - c. Crack cylinder valve slowly

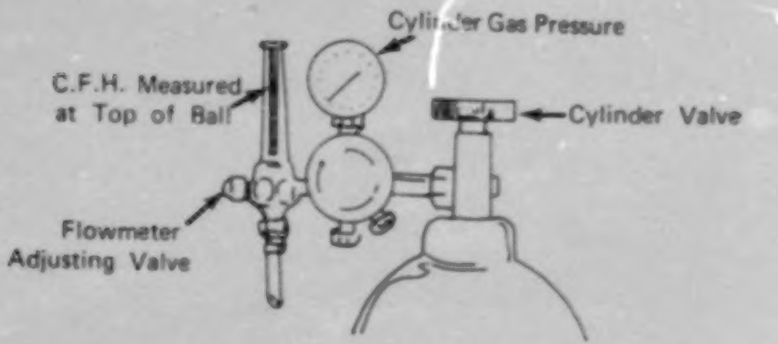
          (NOTE: Check for leaks using soapy water. Ivory soap should be used.)
        - d. Turn wire speed control to zero or release pressure on feed rolls
        - e. Open flowmeter adjusting valve slowly while depressing gun trigger

          (NOTE: Some machines do have preset regulators and are not adjusted manually.)

JOB SHEET #1

f. Adjust desired flow rate (c.f.h.) and release trigger (Figure 1)

FIGURE 1



(NOTE: This is accurate only if gas in cylinder exceeds 50 p.s.i. and is mounted vertically.)

3. Set wire feed speed (amperage control) to desired setting

(NOTE: Arc voltage and amps should be fine tuned while or after running ahead on scrap metal.)

C. Set up gun

1. Conduit and liners that transport wire to gun should be correct size as well as clean and free of obstructions

(NOTE: Do not use solvents to clean nylon liners used for aluminum.)

2. Contact tip or tube should be correct size for wire being used and free of grease, dirt, or spatter

3. Nozzle should be correct size for welding applications and gas flow volumes as well as free from spatter

(NOTE: Some form of anti-spatter compound, either spray can or paste, should be applied to nozzle and contact tip before welding to help prevent spatter build up.)

4. Adjust and maintain correct stick out (Figure 2, next page)

   a. Short arc--1/4"-3/8"

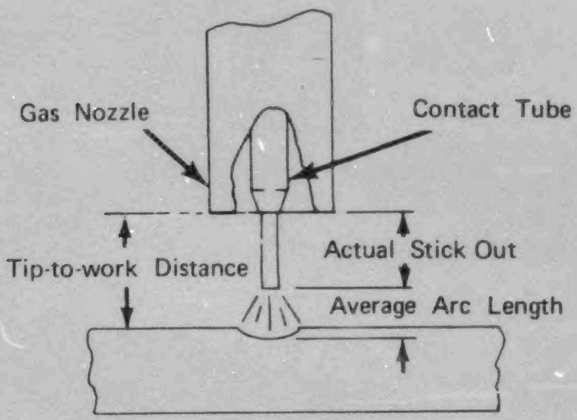
   b. Spray arc--3/4"-1"

JOB SHEET #1

c. Flux cored--1/4"-2 1/2"

(NOTE: In this unit, stick out shall refer to the tip-to-work distance.)

FIGURE 2


Gas Nozzle
Contact Tube
Actual Stick Out
Tip-to-work Distance
Average Arc Length

III. Shut down procedure

- A. Turn off wire feed speed control
  - 1. Set control to zero
  - 2. Move wire feed control switch to off after bleeding gas lines
- B. Shut off shielding gas system (if used)
  - 1. Close cylinder valve
  - 2. Depress welding gun trigger until ball in flowmeter zeros
  - 3. Close flowmeter adjusting valve finger tight
- C. Turn off welding power supply
- D. Store gun and cable assembly in correct place

GAS METAL ARC WELDING
UNIT V

JOB SHEET #2--CONSTRUCT A MULTIPLE PASS T-JOINT FILLET WELD IN THE HORIZONTAL POSITION

I. Equipment and materials needed

   A. GMAW power supply, wire feeder, and air cooled gun for short arc application

   B. Shielding gas--Co_2 or C-25 at 20 c.f.h. (25%% Co2; 75% argon)

   C. Electrode filler wire--.035 diameter A.W.S. #E705-3

   D. Current setting--(DCRP) 140-160 amps (wire feed speed)

   E. Voltage setting--19-21 arc volts

   F. Material--2 pieces 3/16" x 3" x 6" mild steel

   G. Personal protective equipment

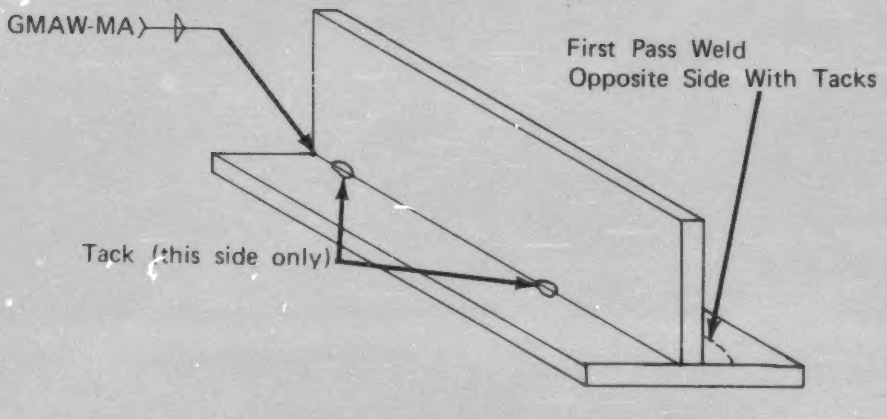
II. Procedure

   A. Adjust power supply and wire feeder to correct voltage and amperage

   B. Set shielding gas flow rate 20 c.f.h.

   C. Position two plates to form a T-joint and tack (Figure 1)

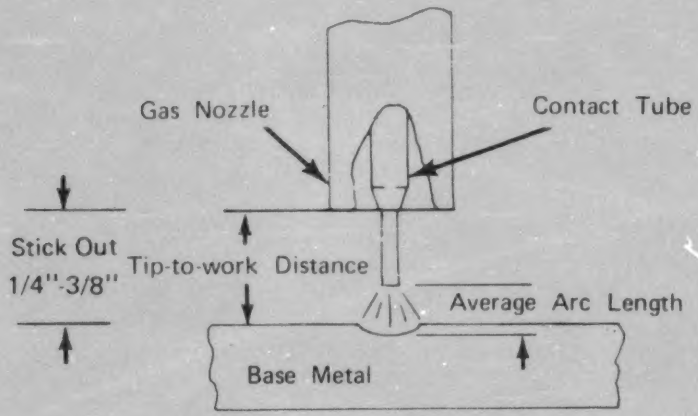
FIGURE 1



JOB SHEET #2

D. Maintain correct stick out of 1/4"-3/8" (Figure 2)

FIGURE 2

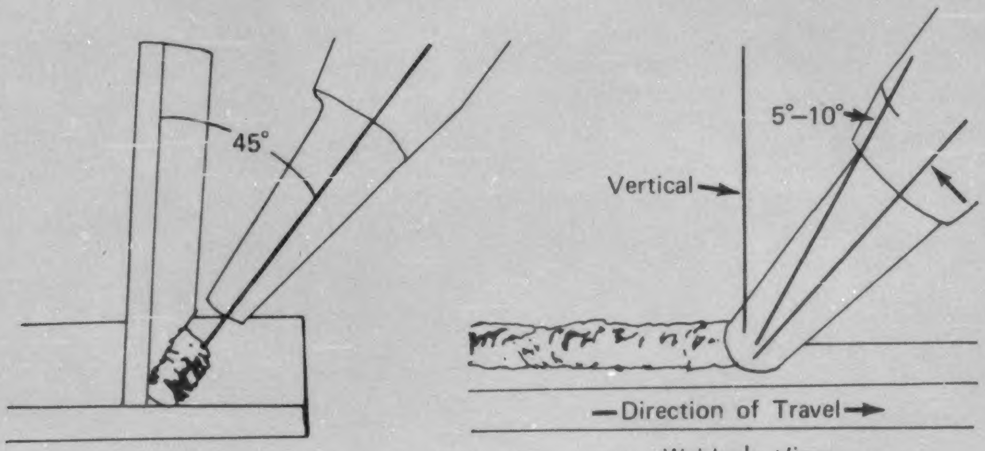

Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length
Base Metal

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Place metal in flat position

F. Position gun at 45° side angle and 5°-10° in direction of travel for first and second bead (Figure 3)

FIGURE 3


45°
5°–10°
Vertical
Direction of Travel

End View

Weldor's View

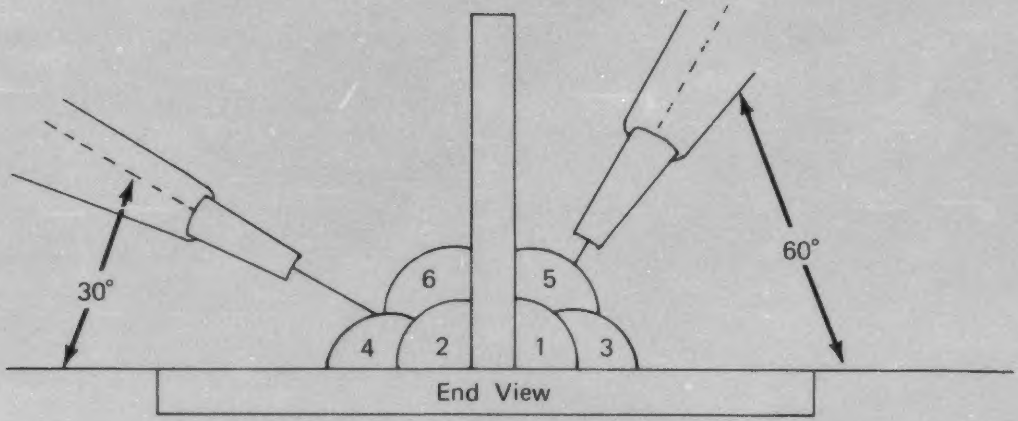
JOB SHEET #2

G. Start arc one inch from starting end of joint moving quickly to starting end of joint and begin first bead

(NOTE: This technique is used to prevent cold lap, a problem common to GMAW.)

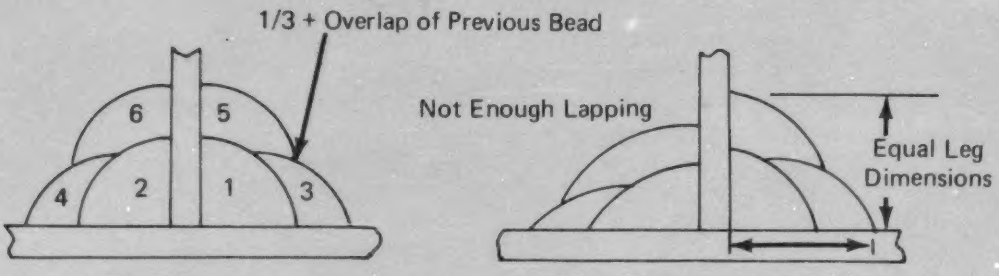
H. Position gun at 60° angle to bottom plate for third and fourth beads and 30° angle to bottom for fifth and sixth beads (Figure 4)

FIGURE 4


30°
60°
6
5
4
2
1
3
End View

I. Overlap all beads one-third (Figure 5)

FIGURE 5


1/3 + Overlap of Previous Bead
6
5
4
2
1
3
Not Enough Lapping
Equal Leg Dimensions

Bead Sequence

AVOID THIS

DO THIS

(NOTE: Remember to alternate beads to prevent distortion as shown in Figure 5.)

J. After completing required number of passes, turn in for instructor's approval

GAS METAL ARC WELDING
UNIT V

JOB SHEET #3--CONSTRUCT A LAP JOINT FILLET WELD IN THE VERTICAL DOWN POSITION

I. Equipment and materials needed

   A. GMAW power supply, wire feeder, and air cooled gun for short arc application

   B. Shielding gas Co$_2$ or C-25 at 20 c.f.h. (25% Co$_2$; 75% argon)

   C. Electrode filler wire--.035 diameter A.W.S. #E705-3

   D. Current setting--DCRP 140-160 amps (wire feed speed)

   E. Voltage setting 19-21 arc volts

   F. Material--2 pieces mild steel 3/16" x 3" x 6"

   G. Personal protective equipment

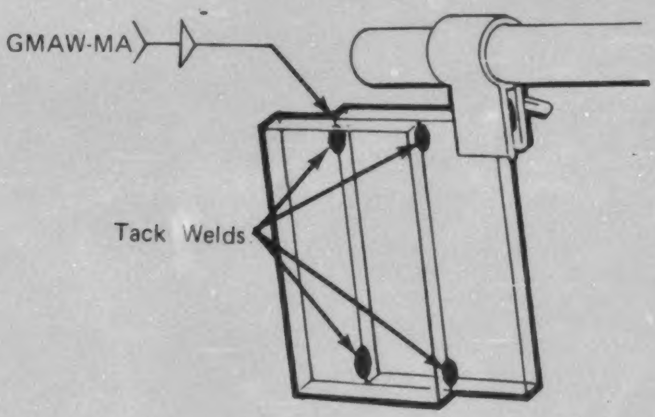
II. Procedure

   A. Adjust power supply and wire feeder to correct voltage and amperage

   B. Set shielding gas flow rate 20 c.f.h.

   C. Position two plates to form a lap joint and tack (Figure 1)

FIGURE 1

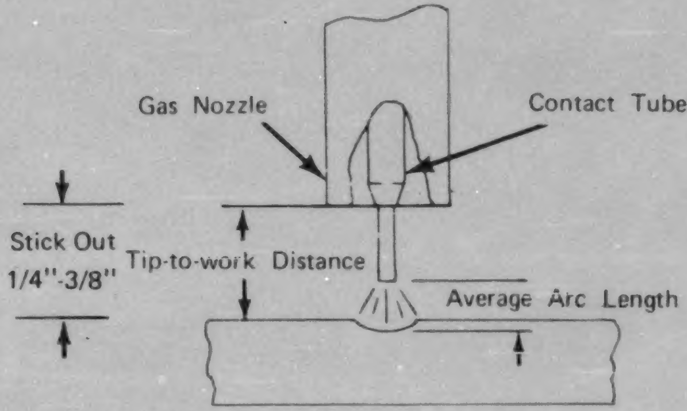


   D. Position plate in vertical position as shown in Figure 1

JOB SHEET #3

E. Adjust and maintain correct stick out distance of 1/4-3/8 inch (Figure 2)

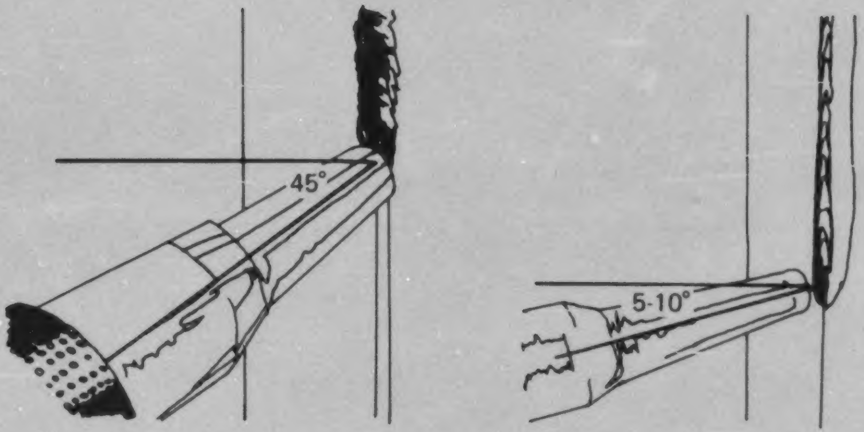
FIGURE 2


Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

F. Position gun at 45° side angle and 5°-10° down from horizontal (Figure 3)

FIGURE 3



Weldor's View

Side View

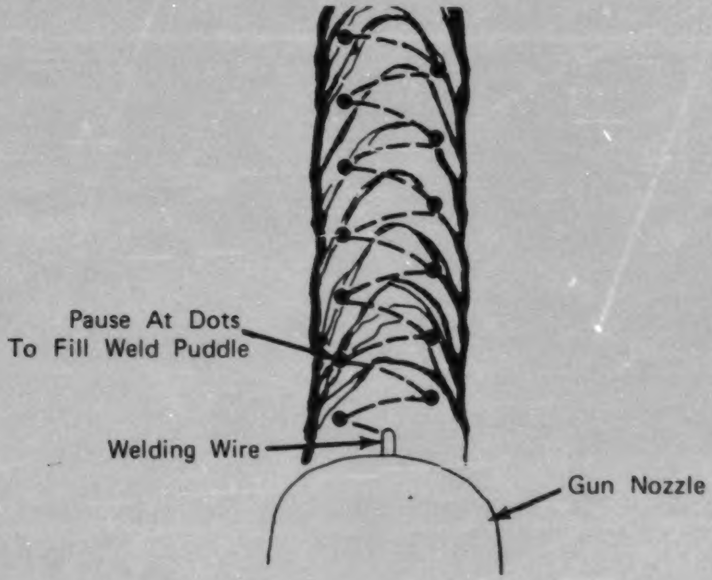
JOB SHEET #3

G. Start arc approximately one inch from top of plates; then move to top and start weld progressing from top to bottom

(NOTE: Some starting technique similar to this should be used to prevent cold lap.)

H. Using a weaving motion, pause on the sides of the joint and travel at the correct speed to fill joint completely (Figure 4)

FIGURE 4



(NOTE: Check with instructor for complete details on electrode manipulation.)

I. Weld opposite side using same procedure

J. After completion of joint, turn in for instructor's approval

GAS METAL ARC WELDING
UNIT V

JOB SHEET #4--CONSTRUCT A SQUARE GROOVE BUTT JOINT IN THE FLAT POSITION WITH SHORT ARC

I. Equipment and materials needed

  A. GMAW power supply, wire feeder, and air cooled gun for short arc application

  B. Shielding gas Co_2 or C-25 at 20 c.f.h. (25% Co_2; 75% argon)

  C. Electrode filler wire--.035 diameter A.W.S. #E705-3

  D. Current setting--DCRP 110-120 amps (wire feed speed)

  E. Voltage setting 16-19 arc volts

  F. Material--2 pieces mild steel 3/16" x 3" x 6"

  G. Personal protective equipment

II. Procedure

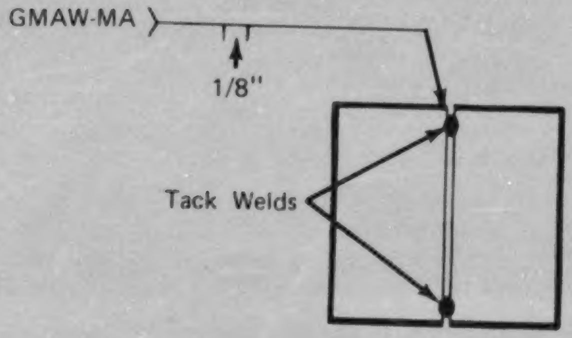
  A. Adjust power supply and wire feeder to correct voltage and amperage

  B. Set shielding gas flow rate 20 c.f.h.

  C. Position material to form a butt joint with 1/8" root gap and tack (Figure 1)

  (NOTE: Be sure root gap spacing is slightly wider than 1/8" to allow for shrinking of tack and that joint is aligned before tacking. One-eighth inch mild steel filler rod can be used to gap the joint.)

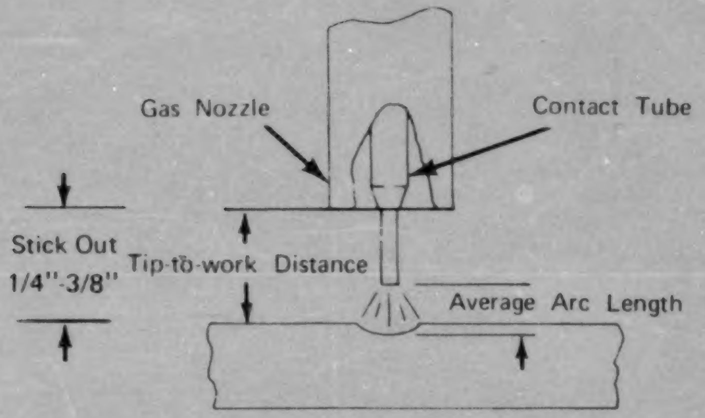
FIGURE 1



JOB SHEET #4

D. Adjust and maintain during welding procedure a stick out of 1/4-3/8 inch (Figure 2)

FIGURE 2


Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

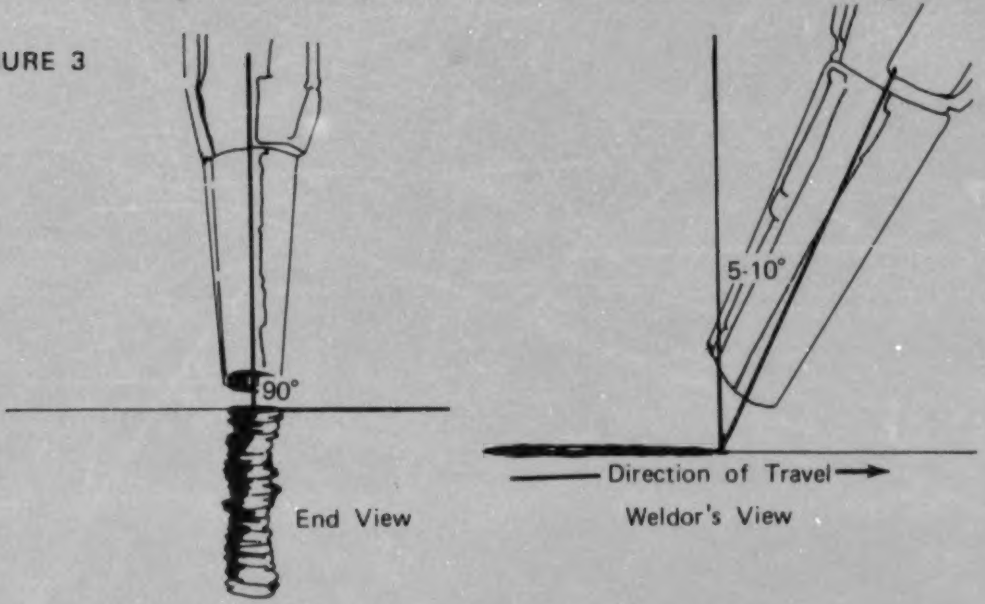
(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Place metal in flat position

(NOTE: Space metal off table to avoid welding to table through root of joint.)

F. Hold gun in vertical position and 5°-10° in direction of travel (Figure 3)

FIGURE 3

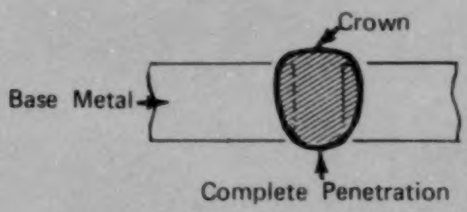

90°
End View
5-10°
Direction of Travel
Weldor's View

JOB SHEET #4

G. Start arc 1/2"-3/4" from end of joint; then move to end of joint and begin welding keeping the following points in mind:

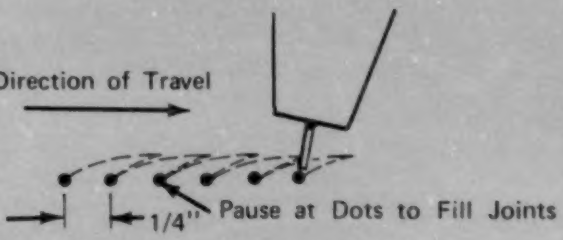
1. Travel at a speed to penetrate the joint completely (Figure 4)

FIGURE 4


Crown
Base Metal
Complete Penetration

2. Bead crown should be higher than surface of base metal
3. Electrode wire should be fed into leading edge of puddle being careful to avoid pushing wire through root of joint and out back of plates making whiskers
4. Weld puddle can be controlled by a whipping and pause motion of electrode (Figure 5)

FIGURE 5


Direction of Travel
1/4"
Pause at Dots to Fill Joints

5. Avoid excessive lengthening of stick out when oscillating gun
6. Varying electrode can be helpful in controlling weld bead

H. At end of joint, be sure to fill crater

I. Inspect root of weld for correct penetration and turn in for instructor's approval

GAS METAL ARC WELDING
UNIT V

JOB SHEET #5--CONSTRUCT A SQUARE GROOVE BUTT JOINT IN THE HORIZONTAL POSITION WITH SHORT ARC

I. Equipment and materials needed

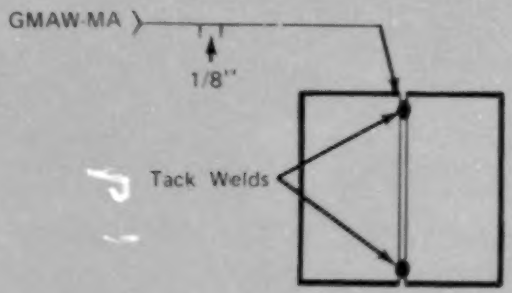
- A. GMAW power supply, wire feeder, and air cooled gun for short arc application
- B. Shielding gas Co_2 or C-25 at 20 c.f.h. (25% Co_2; 75% argon)
- C. Electrode filler wire--.035 diameter A.W.S. #E705-3
- D. Current setting--DCRP 110-120 amps (wire feed speed)
- E. Voltage setting 16-19 arc volts
- F. Material--2 pieces mild steel 3/16" x 3" x 6"
- G. Personal protective equipment

II. Procedure

- A. Adjust power supply and wire feeder to correct voltage and amperage
- B. Set shielding gas flow rate 20 c.f.h.
- C. Position material to form a butt joint with 1/8" root gap and tack (Figure 1)

  (NOTE: Be sure root gap spacing is slightly wider than 1/8" to allow for shrinking of tack and that joint is aligned before tacking. One-eighth inch mild steel filler rod can be used to gap the joint.)

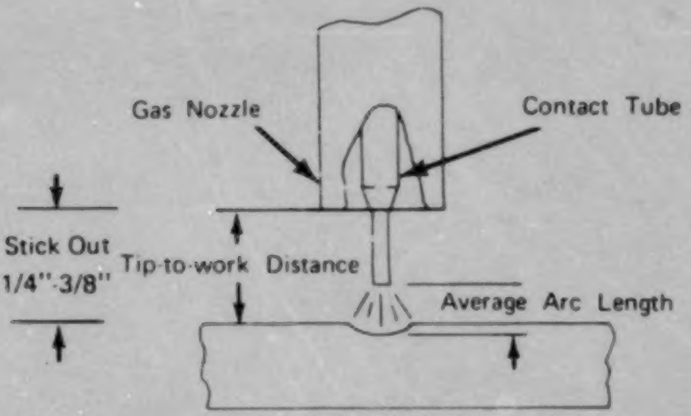
FIGURE 1



JOB SHEET #5

D. Adjust and maintain during welding procedure a stick out of 1/4-3/8 inch (Figure 2)

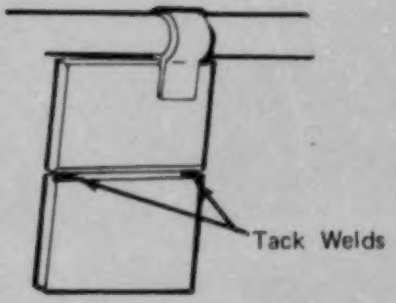
FIGURE 2


Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Place metal in the horizontal position (Figure 3)

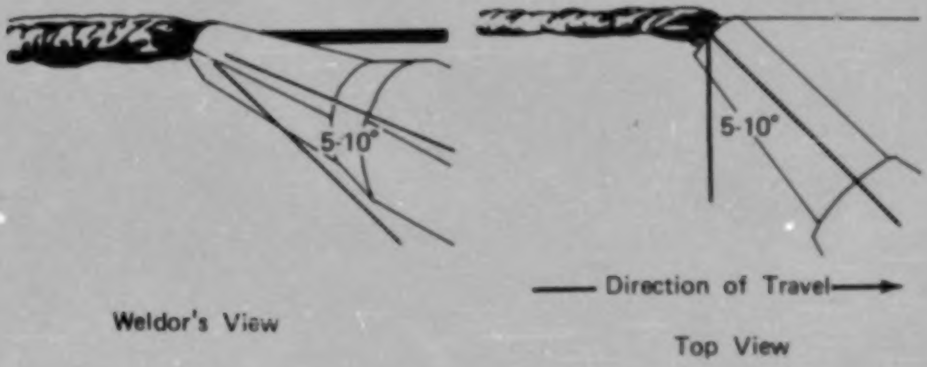
FIGURE 3



JOB SHEET #5

F. Position gun 5°-10° down from horizontal and 5°-10° in direction of travel (Figure 4)

FIGURE 4



G. Start arc 1/2"-3/4" from end of joint to avoid cold lap; then move to end of joint and begin welding keeping in mind the following points

  1. Travel at speed to penetrate joint completely
  2. Some form of electrode manipulation will be helpful in controlling puddle
  3. Feed electrode filler wire into leading edge of puddle being careful to avoid getting too close or wire will plunge through to root side of weld causing whiskers to develop

H. Be sure to fill crater at end of joint

I. Inspect weld for complete penetration at the root and turn in for instructor's approval

GAS METAL ARC WELDING
UNIT V

TEST

1. Match the following terms with their definitions.

_____a. Heat generated by the flow of current through the gap between the end of the wire and the workpiece; voltage appears across this gap and varies in the same direction as the length of the arc

_____b. Will usually be direct current reverse polarity (DCRP) with the welding wire positive (+) and the work negative (-)

_____c. Arc welding process in which a consumable bare electrode is fed into a weld joint at a controlled rate while a continuous blanket of gas, inert or otherwise, shields the weld zone from contamination by the atmosphere

_____d. Abbreviation for flux cored arc welding; a form of GMAW performed with a cored consumable electrode (flux inside the wire)

_____e. Welding application of the GMAW process where low currents, low voltages, and small diameter wires are used to weld on thin to heavy metals in all positions

_____f. Voltage indicated by a volt meter on GMAW power supply when machine is welding

_____g. Any metal containing iron such as mild steel or stainless steel

_____h. Any metal that contains no iron such as aluminum or magnesium

1. Slope
2. Arc voltage
3. Slope control
4. Ferrous
5. Inductance
6. Open circuit voltage
7. Nonferrous
8. Stick out
9. Short circuiting transfer (short arc)
10. FCAW
11. Welding voltage (arc length)
12. Whiskers
13. Welding current (amperage)
14. Gas metal arc welding (GMAW)
15. Shielding gases

______i. The slant of the volts versus amps curve, generally referred to as volts change per 100 amps

______j. A control on the power supply that regulates the amount of pinch force available on the welding wire, thereby controlling spatter or the pinch effect

______k. Controls the rate of rise of current without controlling the final amount of current available

______l. Distance from the contact tip of the gun to the end of the electrode

______m. Short lengths of welding wire that feed through the root gap of a grooved joint and extend out from the root of the weld in all directions

______n. Voltage indicated by volt meter on GMAW power supply when machine is running but not welding

______o. Gases, inert or otherwise, used to displace the air around the arc to prevent contamination by oxygen, nitrogen, or hydrogen from the atmosphere

2. List six advantages of the GMAW process.

a.

b.

c.

d.

e.

f.

3. Identify the major parts of the GMAW equipment.

a.

b.

c.

d.

e.

f.

g.

h.

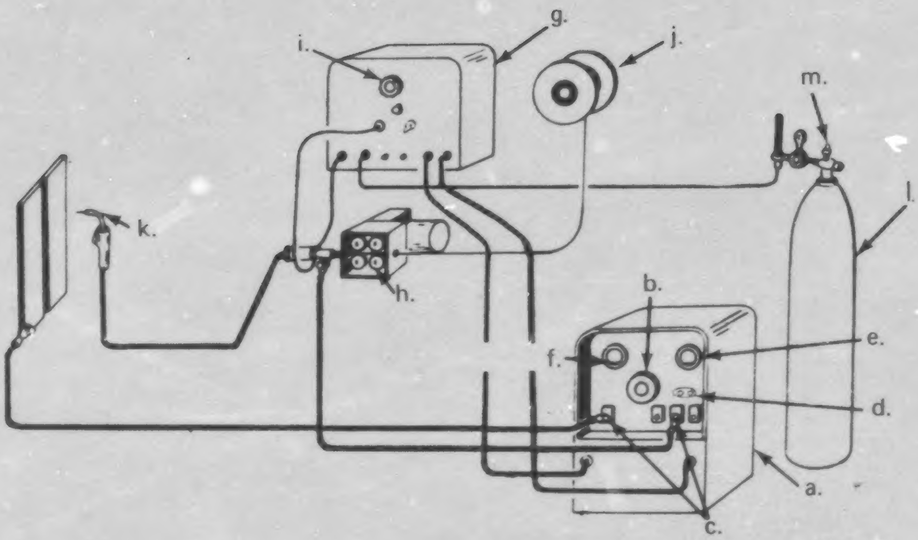
i.

j.

k.

l.

m.


g.
i.
j.
m.
l.
k.
h.
b.
e.
f.
d.
a.
c.

4. Select from the following list three applications of the GMAW process by placing an "X" in front of the application.

______a. Short circuiting (short arc)

______b. Stuk electrode

______c. Spray arc

______d. Gas welding

______e. Flux cored wire

5. List four factors to be considered when selecting a filler wire for the GMAW process.

a.

b.

c.

d.

6. Name the two types of mild steel welding wires used in GMAW welding.

a.

b.

7. Match the shielding gases to their use(s).

______a. Used to weld aluminum and magnesium

______b. Used to weld heavy sections of aluminum

______c. Used to weld mild and stainless steels

______d. Used for mild steel with short arc and flux cored application

______e. Used on mild, stainless, and alloy steels and copper alloys

1. Argon-Co_2
2. Argon
3. Argon-Helium
4. Helium Argon Co_2
5. Co_2
6. Argon-Oxygen

8. Identify the causes of poor welds by matching the cause to the illustration.

______a. Cold lapping (incomplete fusion)

______b. Excessive penetration

(Continued on next page)

______c. Insufficient penetration

______d. Burn-through

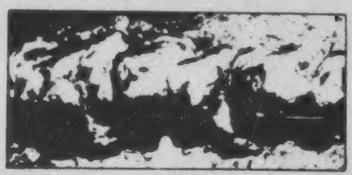
______e. Surface porosity

______f. Poor appearance

______g. Whiskers

______h. Bad tie-in

______i. Suck-back (internal concavity)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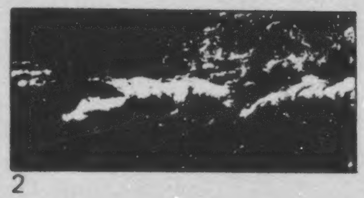
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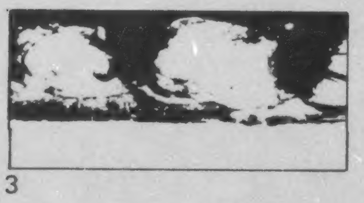
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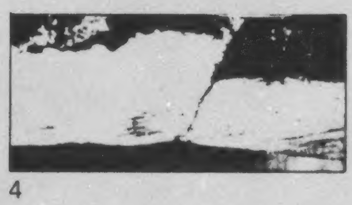
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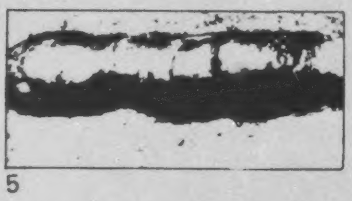
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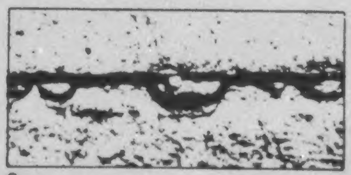
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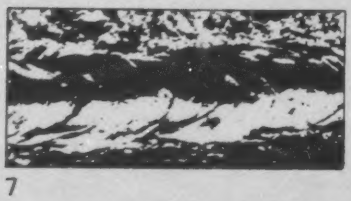
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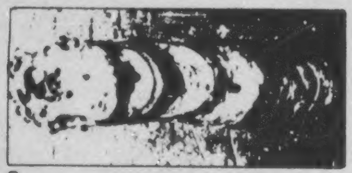
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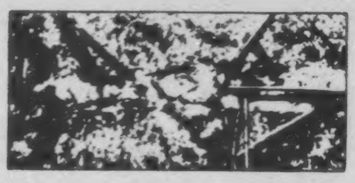
9

9. List the characteristics of a good weld.

   a.

   b.

   c.

10. Name the two types of power sources for GMAW.

    a.

    b.

11. Describe the effects of electrode wire stick out on volts and amps.

    a. Increased stick out (long arc)

    b. Short stick out (short arc)

12. Demonstrate the ability to:

    a. Set up and shut down the GMAW equipment for short arc, spray arc, and flux cored arc welding applications.

    b. Construct a multiple pass T-joint fillet weld on mild steel in the horizontal position with short arc.

    c. Construct a lap joint fillet weld on mild steel in the vertical down position with short arc.

    d. Construct a square groove butt joint on mild steel in the flat position with short arc.

    e. Construct a square groove butt joint on mild steel in the horizontal position with short arc.

    (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

GAS METAL ARC WELDING
UNIT V

ANSWERS TO TEST

1.
   a. 11
   b. 13
   c. 14
   d. 10
   e. 9
   f. 2
   g. 4
   h. 7
   i. 1
   j. 3
   k. 5
   l. 8
   m. 12
   n. 6
   o. 15

2. Any six of the following
   a. Arc always visible to the welder
   b. No slag and a minimum amount of spatter
   c. High disposition rate with 95% of the welding wire deposited in the joint
   d. Weld metal deposit of low hydrogen quality
   e. Wide range of metal thicknesses can be welded without changing wire
   f. Excellent for bridging gaps or misaligned joints without burn-through

g. Greatly reduced distortion in gage metal

h. Adaptable to weld most any metal by the selection of correct filler wire and shielding gases

i. Adaptable to either automatic or semiautomatic

3. a. Power supply

b. Voltage control

c. Welding terminals

d. Power on-off switch

e. Volt meter

f. Amp meter

g. Wire feed control system

h. Feed rolls

i. Wire feed control (amperage)

j. Wire reel or coil

k. Gun

l. Shielding gas

m. Flowmeter

4. a, c, e

5. a. Metal to be welded

b. Metal thickness and joint design

c. Metal surface condition

d. Specifications of the job

6. a. Solid

b. Flux cored

7. a. 2

b. 3

c. 1 and 4
d. 5
e. 6

8. a. 4
b. 5
c. 6
d. 3
e. 8
f. 1
g. 9
h. 2
i. 7

9. a. Even ripple on bead
b. Slight crown (convex) at root
c. Well fused throughout joint

10. a. Transformer-rectifier
b. Engine or motor generator

11. Description should include:
a. Increases arc volts and decreases amps
b. Increases amps and decreases arc volts

12. Performance skills will be evaluated according to the criteria listed on the progress chart.

Auto Body

PROGRESS CHART

Section E-1
Welding

	Unit I Oxyacetylene Fusion Welding							Unit II Oxyacetylene Braze Welding			Unit III Oxyacetylene Cutting					Unit IV Shielded Metal Arc Welding				
	1	2	3	4	5	6	7	1	2	3	1	2	3	4	5	1	2	3	4	5
Job	Unit Test	Set up Equipment	Turn on, Light, Adjust, & Turn off Equipment	Construct Corner Weld Without Filler Rod	Lay Beads on Light Gauge Metal With & Without Filler Rod	Weld Butt Joints With Filler Rod		Unit Test	Braze Weld a Square Groove Butt Joint		Unit Test	Make 90° Cuts in Mild Steel & Restart a Cut	Make a Flame Beveled Cut on Mild Steel Plate	Cut a Hole in Mild Steel		Unit Test	Start, Stop, and Restart a Bead	Construct a Pad in Flat Position	Construct a Square Groove Butt Weld on Steel Plate	
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
85% Correct																		
To Satisfaction of Instructor																		
To Satisfaction of Instructor																		
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Auto Body
PROGRESS CHART

Section E-2
Welding (continued)

	Unit V Gas Metal Arc Welding																			
	1	2		3		4		5		6		7								
Job	Unit Test	Set up & Shut Down the GMAW Equipment for Short Arc, Spray Arc, and Flux Cored Arc Welding		Construct a Multiple Pass T-Joint Fillet Weld in Horizontal Position with Short Arc		Construct a Lap Joint Fillet Weld in Vertical Down Position with Short Arc		Construct a Square Groove Butt Joint in Flat Position with Short Arc		Construct a Square Groove Butt Joint in Horizontal Position with Short Arc										
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
Accuracy 85% Correct																		
To Satisfaction of Instructor																		
To Satisfaction of Instructor																		
To Satisfaction of Instructor																		
To Satisfaction of Instructor																		
To Satisfaction of Instructor																		

SURFACE PREPARATION--METAL REPAIR
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to explain surface preparation for body repair. He should be able to remove moldings, trim, and clean the exterior and interior surfaces of body panels. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with surface preparation to a list of definitions.
2. Identify the moldings and trim that may need to be removed in surface preparation.
3. Write the purpose of surface preparation.
4. Identify the amount of surface area that needs to be prepared.
5. Describe the correct method for cleaning wax and grease from the exterior panel surface.
6. List three steps of surface preparation for metal repair.
7. Name two advantages of cleaning the surface before metal work is performed.
8. Demonstrate the ability to:
    a. Clean an exterior surface.
    b. Clean an interior surface.

SURFACE PREPARATION-METAL REPAIR
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedure outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency masters

    1. TM 1--Front Moldings and Trim

    2. TM 2--Side Moldings and Trim

    3. TM 3--Rear Moldings and Trim

    4. TM 4--Surface Area to be Cleaned

    5. TM 5--Method for Panel Cleaning

D. Job sheets

  1. Job Sheet #1--Clean the Exterior Surface

  2. Job Sheet #2--Clean the Interior Surface

E. Test

F. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques*. First Edition. Wilmington Delaware: E. T. duPont de Memours and Company, 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Company of Canada Limited, 1969.

C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

D. Spicer, Edward D. *Automotive Collision Work*. Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Toboldt, Bell. *Auto Body Repair and Refinishing*. South Holland, Illinois: Goodheart-Willcox Company, Inc., 1972.

F. *Automotive Refinishing Manuel S-ARMF (385) JPI.* St. Paul, Minnesota: 3M Minnesota Mining and Manufacturing Company.

G. *Motor Crash Estimating Guide*. March 1970, Vo. 2. No. 3. New York: Harst Corporation.

H. *Ford Autolite Body and Collision Parts Catalog*. AF-7832-72, 1972 Edition.

SURFACE PREPARATION--METAL REPAIR
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Detergent--Cleansing agent (soap) which when mixed with water will cleanse oil and dirt from the automobile surface

   B. Water--Used to dilute detergent and rinse the panel surface

   C. Wax and grease remover--A solution for removing wax, grease, oil, and undercoating from automobile panels before body repair work has begun

   D. Exterior panel--The external surface of any body panel

   E. Interior panel--The internal surface of an exterior body panel

   F. Molding--A decorative strip used for ornamentation or finishing

   H. Trim--Decorative emblems

   I. Undercoating--A waterproof coating applied to the undersurface of a vehicle

II. Molding and trim removal (Transparencies 1, 2, and 3)

   A. Front

      1. Hood moldings and trim

      2. Grill

      3. Front bumper

      4. Headlight door

      5. Front fender belt

   B. Side

      1. Windshield reveal

      2. Front door reveal

      3. Front door belt

      4. Front door edge guard

      5. Roof drip

INFORMATION SHEET

        6. Rear door reveal
        7. Rear door belt
        8. Rear door edge guard
        9. Rocker panel
        10. Rear quarter reveal
        11. Rear quarter belt
        12. Back window reveal
        13. Wheel opening moldings
        14. Trim (nameplates, medallions, etc.)

    C. Rear

        1. Deck lid moldings
        2. Rear bumper
        3. Tail light assemblies

III. Purpose of surface preparation--Prolongs the life of abrasive papers and discs and helps the metal finisher by removing contaminates that would interfere with hammer and dolly techniques; it will also aid in avoiding possible paint failures during refinishing

IV. Surface area which needs to be prepared (Transparency 4)

    A. Exterior panel

        1. Prepare entire panel
        2. Prepare adjacent panel if necessary

    B. Interior panel--Prepare at least six inches around the damaged area

V. Method for removing wax and grease from the exterior surface (Transparency 5)

    A. Apply wax and grease removing solution to clean dry cloth

    B. Apply to the old painted surface wetting the surface liberally

    C. While surface is still wet, fold a clean cloth and wipe dry

    (NOTE: To insure solution does not evaporate, only small areas, two or three feet, should be worked at one time. Change cloths often as a dirty cloth will not clean.)

INFORMATION SHEET

VI. Steps for surface preparation

  A. Remove moldings and trim

  B. Clean the exterior surface

  C. Clean the interior surface

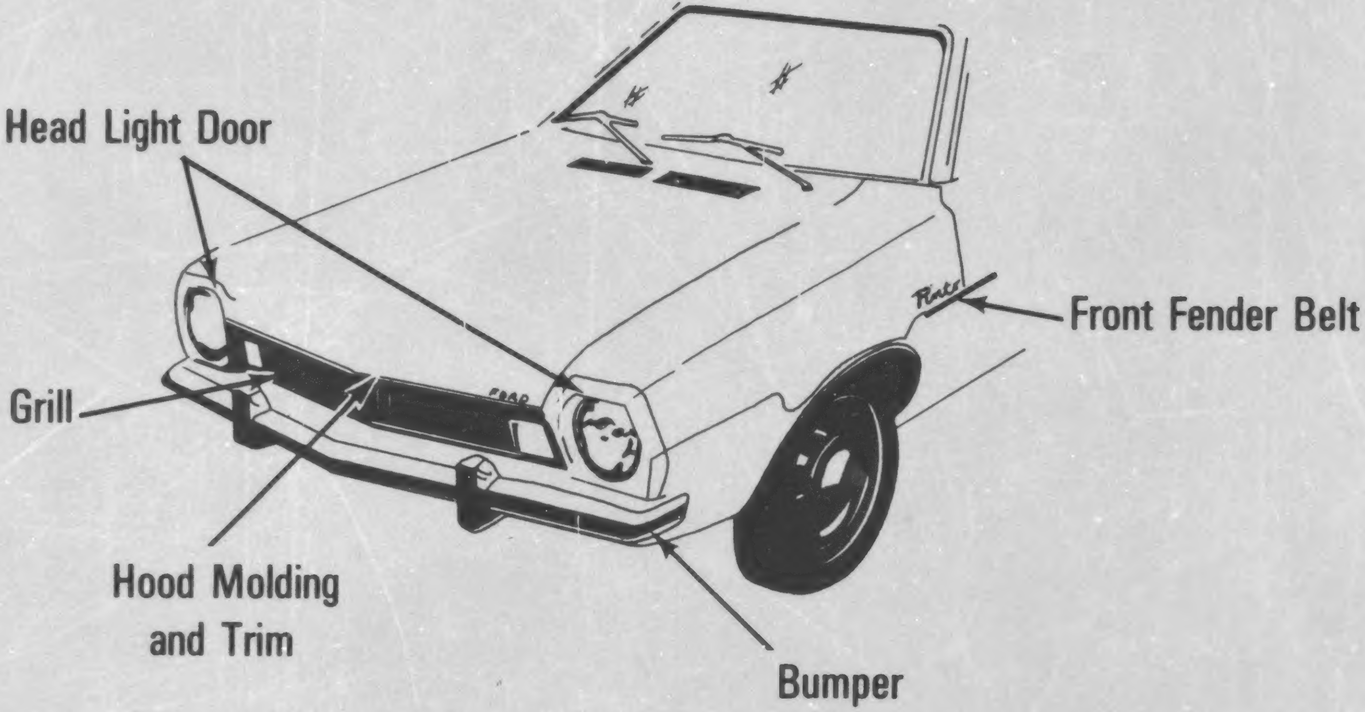
VII. Advantages of cleaning the surface before metal work is performed

  A. Provides a clean working surface

  B. Prolongs life of sandpaper and discs

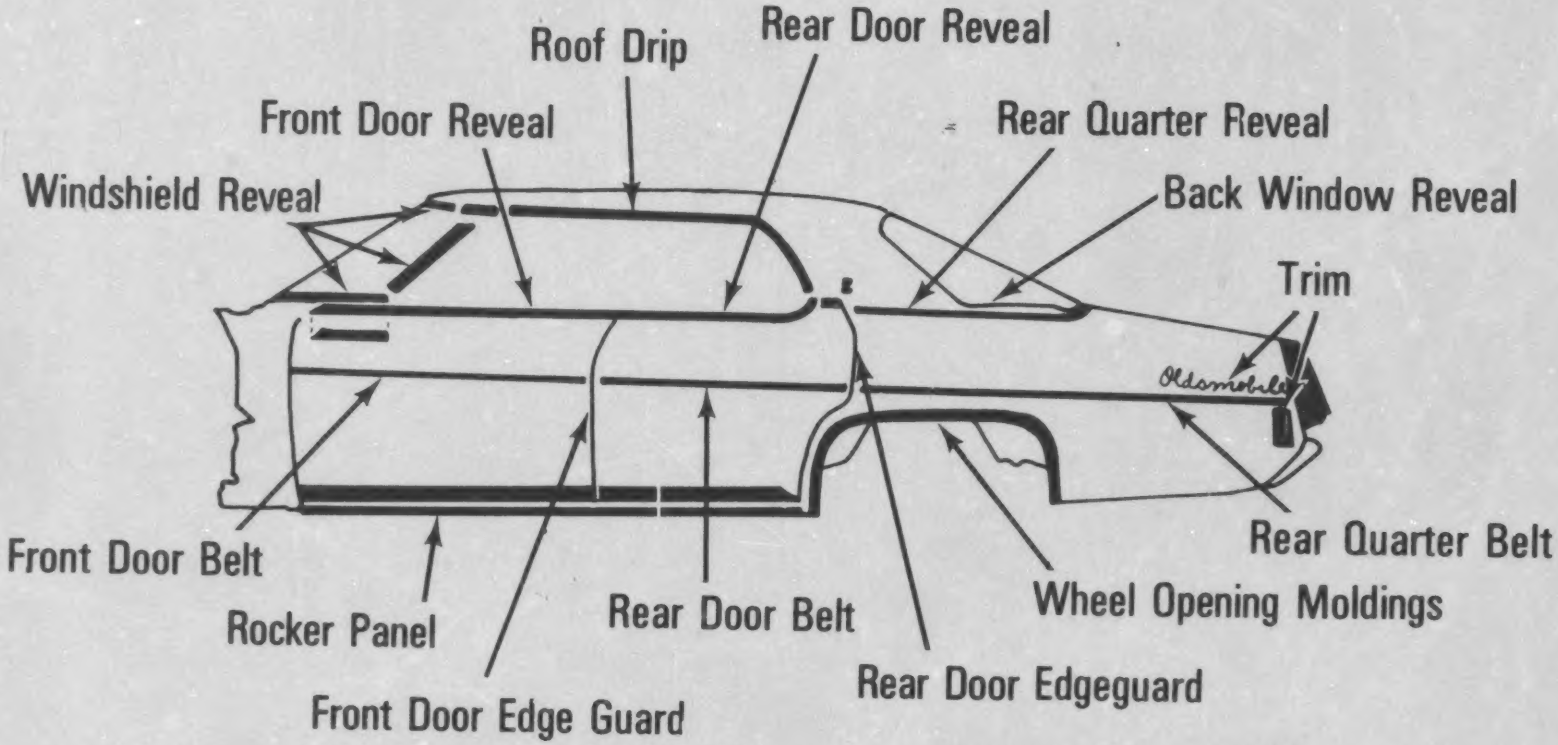
  C. Helps avoid paint failures due to wax and grease being forced into the pores of the metal

Front Moldings and Trim


Head Light Door
Grill
Hood Molding and Trim
Bumper
Front Fender Belt
FORD
Pinto

Front

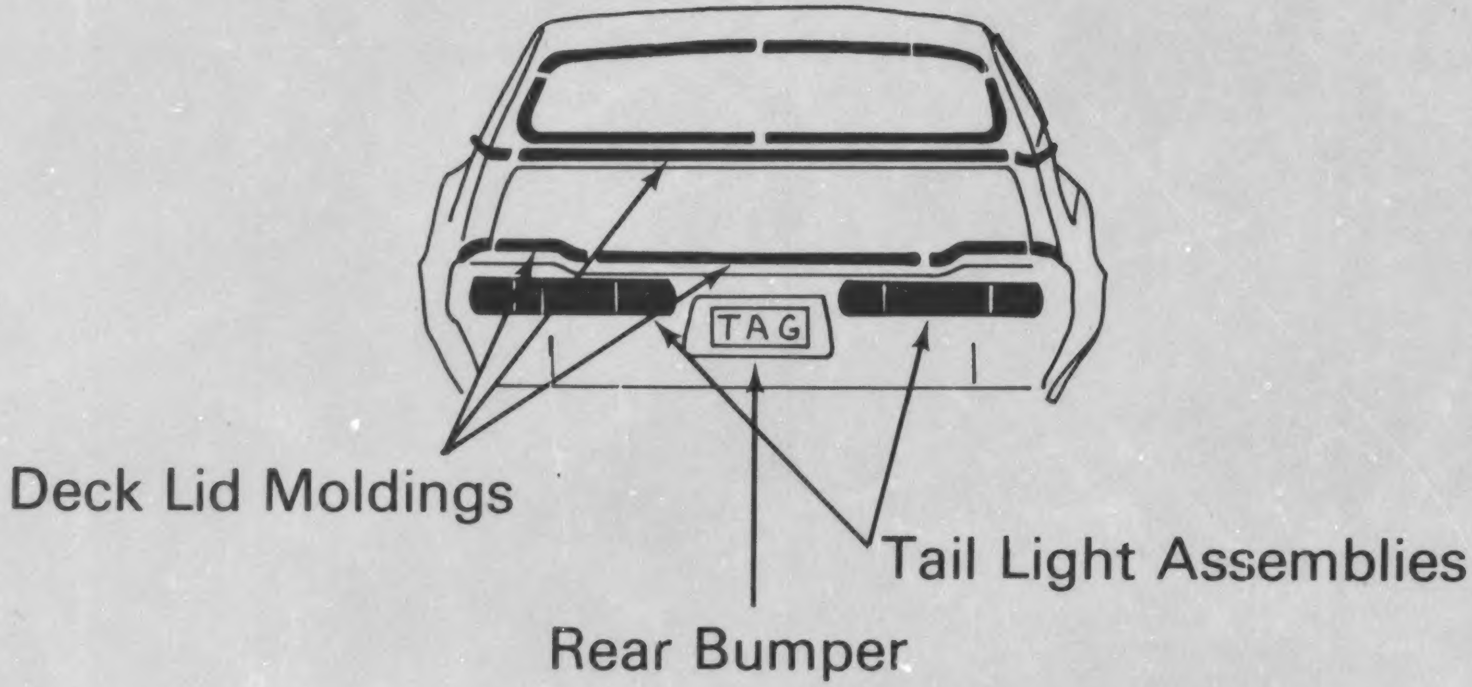
Side Moldings and Trim


Roof Drip
Rear Door Reveal
Front Door Reveal
Rear Quarter Reveal
Windshield Reveal
Back Window Reveal
Trim
Oldsmobile
Front Door Belt
Rear Quarter Belt
Rocker Panel
Rear Door Belt
Wheel Opening Moldings
Rear Door Edgeguard
Front Door Edge Guard

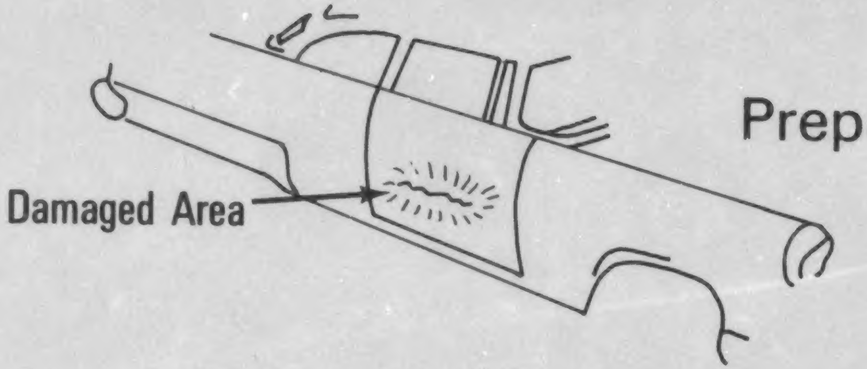
Side

Rear Moldings and Trim

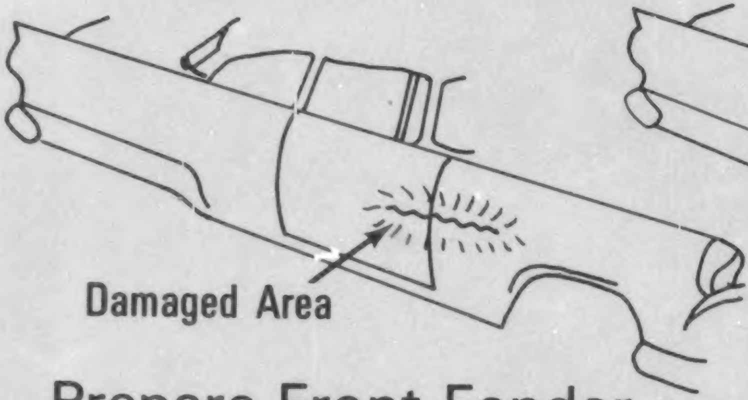
REAR


TAG
Deck Lid Moldings
Tail Light Assemblies
Rear Bumper

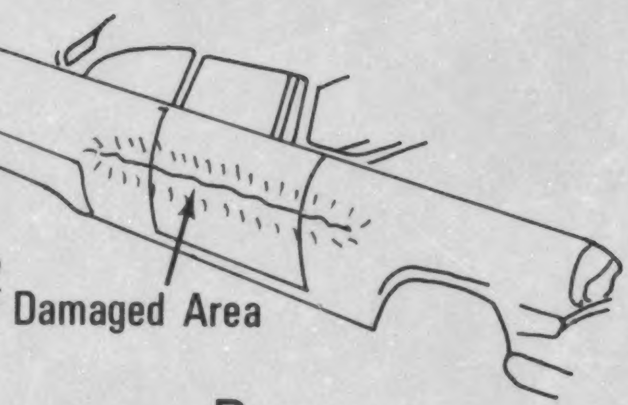
Surface Area to be Cleaned


Damaged Area

Prepare Door

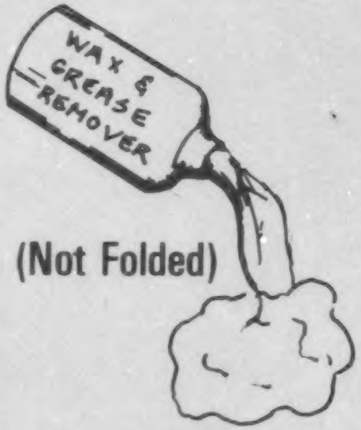

Damaged Area

Prepare Front Fender
and Door


Damaged Area

Prepare
Front Fender, Door,
and Quarter Panel

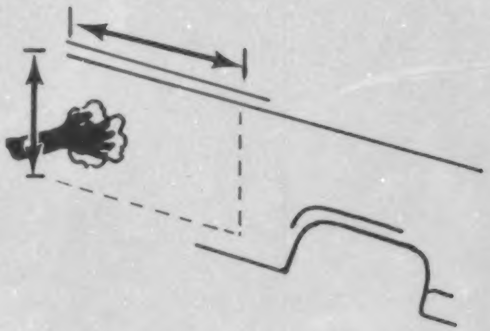
Method for Panel Cleaning



Cloth (Not Folded)

Apply Wax
and Grease
Remover to
Cloth

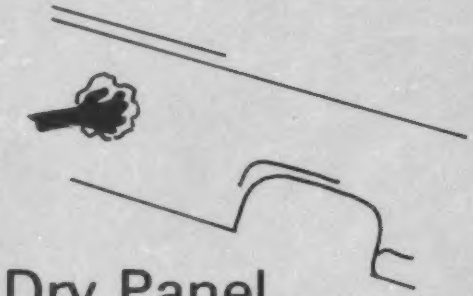
Keep Surface Wet by
Only Cleaning 2' Area at Time



Apply to the
Entire Panel

Dry Area While Wet

Do Not Let Cleaner
Dry on Surface



Dry Panel
with a Clean
Dry Cloth

SURFACE PREPARATION--METAL REPAIR
UNIT I

JOB SHEET #1--CLEAN THE EXTERIOR SURFACE

I. Tools and materials

  A. Screwdrivers

    1. No. 1 and No. 2 phillips

    2. 1/4" x 6" standard blade

  B. 1/4 ratchet set

  C. Combination wrenches 1/4", 5/16", 11/32", 3/8", 7/16", 1/2"

  D. Water pail

  E. Sponge

  F. Detergent

  G. Wax and grease remover

  H. Water

II. Procedure

  A. Remove moldings and trim

  (NOTE: This includes all damaged moldings and trim and those that might be damaged during repair.)

  B. Wash surface of panel with detergent and water

  C. Clean panel with wax and grease remover

SURFACE PREPARATION--METAL REPAIR
UNIT I

JOB SHEET #2--CLEAN THE INTERIOR SURFACE

I. Tools, equipment, and supplies

   A. Scraper

   B. Oxyactylene torch

   C. Wax and grease remover

II. Procedure

   A. Wash surface with soap and water (Remove all caked on mud)

   B. Wash surface with wax and grease remover

   (NOTE: If surface is undercoated, skip "B".)

   C. Warm exterior surface of panel with oxyactylene torch

   (CAUTION: DO NOT BURN PAINT.)

   D. Scrape undercoating off with scraper

   E. Wash interior surface with wax and grease remover

SURFACE PREPARATION--METAL REPAIR
UNIT I

TEST

1. Match the following terms with the correct definitions.

_____a. Cleansing agent which when mixed with water will cleanse oil and dirt from the automobile surface

_____b. Used to dilute detergent and rinse the panel surface

_____c. Solution for removing wax, grease, oil, and undercoating from automobile panels before body repair work has begun

_____d. External surface of any body panel

_____e. Internal surface of an exterior body panel

_____f. A decorative strip used for ornamentation or finishing

_____g. Decorative emblems

_____h. Waterproof coating applied to the undersurface of a vehicle

1. Trim
2. Interior panel
3. Water
4. Wax and grease remover
5. Exterior panel
6. Molding
7. Detergent
8. Undercoating

2. Identify the moldings and trim in the illustration on page 25-F.

a. Front

_____1) Hood molding and trim

_____2) Grill

_____3) Front bumper

_____4) Headlight door

_____5) Front fender belt

b. Rear

_____1) Deck lid moldings

_____2) Rear bumper

_____3) Tail light assemblies

c. Side

_____1) Windshield reveal

_____2) Front door reveal

_____3) Front door belt

_____4) Front door edge guard

_____5) Roof drip

_____6) Rear door reveal

_____7) Rear door belt

_____8) Rear door edge guard

_____9) Rocker panel

____10) Rear quarter reveal

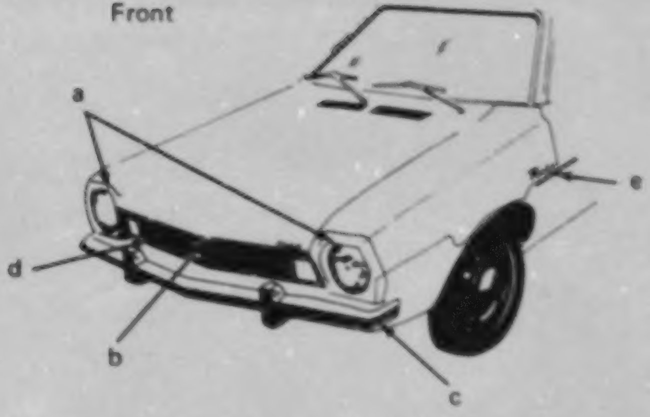
____11) Rear quarter belt

____12) Back window reveal

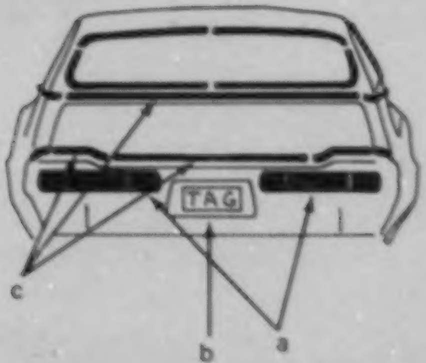
____13) Wheel opening moldings

____14) Trim (nameplates, medallions, etc.)

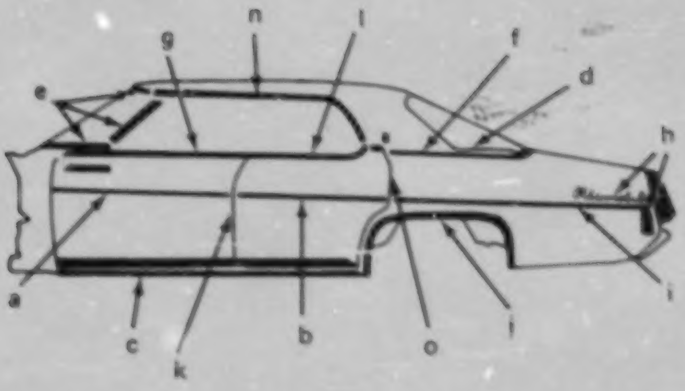
Front



Rear



Side


n
g
l
f
d
e
h
a
c
k
b
o
j
i

3. Write the purpose of surface preparation.

4. Identify the amount of surface that needs to be prepared.

   a. Exterior panel

   b. Interior panel

5. Describe the correct method in three steps for cleaning wax and grease from the exterior panel surface.

   a.

   b.

   c.

6. List three steps of surface preparation for metal repair.

   a.

   b.

   c.

7. Name three advantages for cleaning the surface before metal work is performed.

   a.

   b.

   c.

8. Demonstrate the ability to:

   a. Clean an exterior panel surface.

   b. Clean an interior panel surface.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

SURFACE PREPARATION--METAL REPAIR
UNIT I

ANSWERS TO TEST

1. a. 7
    b. 3
    c. 4
    d. 5
    e. 2
    f. 6
    g. 1
    h. 8
2. a. 1) b
        2) d
        3) c
        4) a
        5) e
    b. 1) c
        2) b
        3) a
    c. 1) e
        2) g
        3) a
        4) k
        5) n
        6) l
        7) i or b

8) o

9) c

10) f

11) b or i

12) d

13) j

14) h

3. Prolongs the life of abrasive papers and discs and helps the metal finisher by removing contaminates that would interfere with hammer and dolly techniques; it will also aid in avoiding possible failures during refinishing

4. a. Prepare entire damaged panel; prepare adjacent panel if necessary

   b. Prepare at least six inches around damaged area

5. a. Apply wax and grease remover to clean dry cloth

   b. Apply to the old painted surface wetting the surface liberally

   c. While surface is still wet, fold a clean cloth and wipe dry

6. a. Remove moldings and trim

   b. Clean the exterior surface

   c. Clean the interior surface

7. a. Provides a clean working surface

   b. Prolongs life of sandpaper and discs

   c. Helps avoid paint failures due to wax and grease being forced into the pores of the metal

8. Performance skills will be evaluated according to the criteria listed on the progress chart.

ROUGHOUT
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with roughout and analyze and determine the order of repair of a damaged automobile. He should be able to fit body panels to proper dimensions and specifications and roughout all repairable panels to proper dimensions. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with roughout to a list of definitions.
2. State the purpose for aligning detachable parts.
3. List three steps the repairman must consider in analyzing the job.
4. List three clues that determine the direction of the damage.
5. Name the effects of bending body sheet metal.
6. Name the effects of bending hollow (box section) metal.
7. Describe the use of the dolly in roughout.
8. Identify the hammering on and off the dolly techniques.
9. Describe the picking technique.
10. Demonstrate the ability to:
    a. Align a hood.
    b. Align a fender.
    c. Align a headlight assembly.
    d. Align a bumper.
    e. Align a door.
    f. Align a deck lid.
    g. Align a taillight assembly.

h. Align moldings and trim.

i. Roughout a single crowned panel and/or combination crowned panel.

j. Roughout a low crowned panel.

k. Roughout a double high crowned panel.

l. Roughout a reversed crown panel.

m. Roughout a flange or bead.

ROUGHOUT
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Elasticity

      2. TM 2--Plastic Deformation

      3. TM 3--Work Hardening

      4. TM 4--Direct Damage, Indirect Damage, and Direction of Impact

      5. TM 5--Stretch

    6. TM 6--Pressure and Tension
    7. TM 7--Hinge Buckle
    8. TM 8--Roll Buckle
    9. TM 9--Effects of Bending Body Sheet Metal
    10. TM 10--Effects of Bending Hollow (Box Section) Metal
    11. TM 11--Use of a Dolly in Roughout
    12. TM 12--Hammering On the Dolly
    13. TM 13--Hammering Off the Dolly
    14. TM 14--Picking

  D. Job sheets
    1. Job Sheet #1--Align a Hood
    2. Job Sheet #2--Align a Fender
    3. Job Sheet #3--Align a Headlight Assembly
    4. Job Sheet #4--Align a Bumper
    5. Job Sheet #5--Align a Door
    6. Job Sheet #6--Align a Deck Lid
    7. Job Sheet #7--Align a Taillight Assembly
    8. Job Sheet #8--Align Moldings and Trim
    9. Job Sheet #9--Roughout a Single Crowned Panel and/or Combination Crowned Panal
    10. Job Sheet #10--Roughout a Low Crowned Panel
    11. Job Sheet #11--Roughout a Double High Crowned Panel
    12. Job Sheet #12--Roughout a Reversed Crown Panel
    13. Job Sheet #13--Roughout a Flange or Bead

  E. Test

  F. Answers to test

II. References:

  A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Company of Canada Limited, 1969.

B. McPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Book Company Inc., 1971.

C. Richert, Melvin T. *How to Control Auto Body Sheet Metal,* First Edition. Philadelphia, Pennsylvania: Chelton Book Company, 1968.

D. Spicer, Edward D. *Automotive Collision Work,* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Toboldt, Bill. *Auto Body Repairing and Repainting.* Third Edition. South Holland, Illinois: The Goodheart-Willcox Company Inc., 1972.

ROUGHOUT
UNIT II

INFORMATION SHEET

I. Terms and definitions (Transparencies 1, 2, 3, 4, 5, 6, 7, and 8)

   A. Roughout--The stage in body repair where dimensions are established, damaged panels are aligned, and dents are reshaped to proper dimensions

   B. Elasticity--The ability of auto body sheet metal to stretch and return to its original position

   C. Elastic limit--The point that metal can be stretched and still recover

   D. Plastic deformation--Ductility or having the ability to yield to bending or forming

   E. Work hardening--Change of the grandular structure of metal by bending or forming; work hardening occurs in the bend and the metal becomes hardened and strengthened

   F. Direct damage--Damage which is the direct result of the collision force at the point of impact and the immediately surrounding area

   G. Indirect damage--When the impact force travels through the direct damage area surrounding the point of impact, then causes damage to other areas of the same panel or connecting panels and areas

   H. Direction of impact--The direction that the metal has shifted from the impact point

   I. Stretch--Swelling and thinning of metal due to improper hammer and dolly technique; this can result from bending and pulling

      Example: Oil canning

   J. Upset--Opposite of stretch; compressing the metal

   K. Pressure--The pushing force or point of direct damage to a body panel; metal that is pushed up

   L. Tension--A pulling force; metal that is pushed down

   M. Hinge buckle--Bending or pivot point from which two areas of relatively undamaged metal have moved or shifted

   N. Roll buckle--When metal on each side of the pivot point is pulled together and forced to roll over on its side

INFORMATION SHEET

II. Purpose for aligning detachable parts--To help set dimensions and specifications for repair of body panels and installation of outer finish panels

III. Steps in analyzing job

A. Extent of damage

B. Method of repair

C. Order of repair

IV. Clues that determine the direction of damage

A. Rolled buckles--These buckles move away from the point of first contact; when there are two or three they will converge (like spokes of a wheel to the hub) at the point of first contact

B. Direct damage marks--The direction of damage always ends at the mark created by the impact object

C. Pressure forces--The side of the greatest pressure shift of metal will indicate which way the metal traveled

V. Effects of bending body sheet metal (Transparency 9)

A. Outer surface of bend becomes stretched

B. Center remains the same

C. Inner surface is upset (compressed and thicker)

VI. Effects of bending hollow (box section) metal (Transparency 10)

A. Upper or top is pulled downward (little or no stretching occurs)

B. Lower or bottom collapses

C. Sides collapse along with bottom

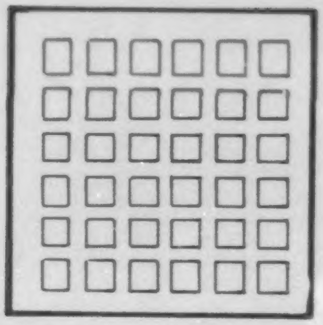
(NOTE: Box sections have no strength in the center. As a result, the upper sheet metal is pulled downward instead of stretching.)

VII. Use of a dolly in roughout (Transparency 11)--Used as an impact tool such as a hitting force to raise low areas and unroll buckles

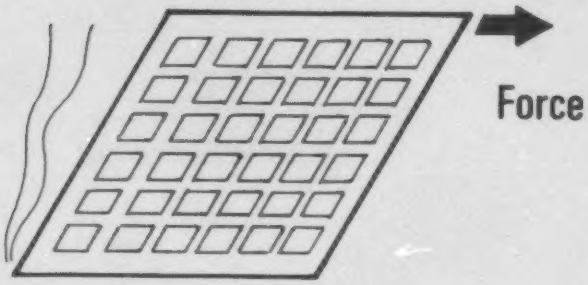
VIII. Hammering on and off the dolly techniques (Transparencies 12 and 13)--Methods used to smooth and stretch metal so it can return to its original shape and raise and lower metal to straighten metal

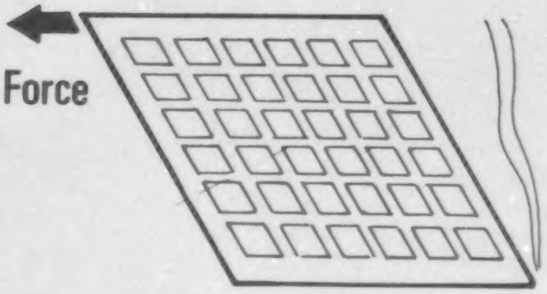
IX. Picking technique (Transparency 14)--Raises up the metal by use of a pointed object (pick hammer, long pick tool, scratch awl, edge of the file or a dolly); picking in roughout raises metal without upsetting the metal

Elasticity

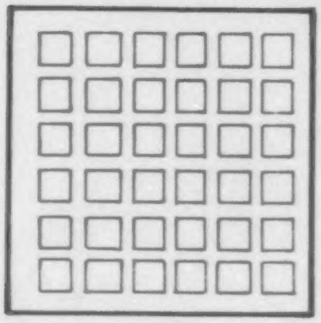


Metal Section Undisturbed and Uniform



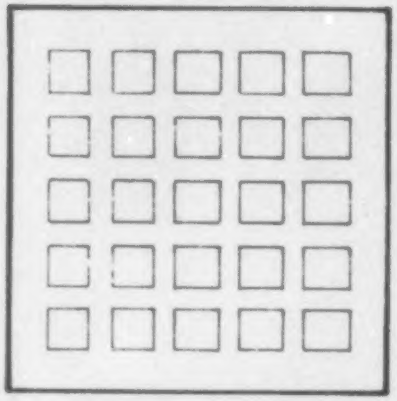


Metal Section Bent, But Not Beyond the Elastic Limit

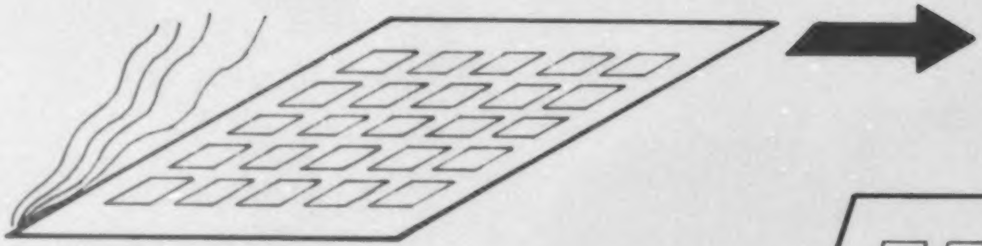


Metal Section Erect Again When No Pressure is Applied

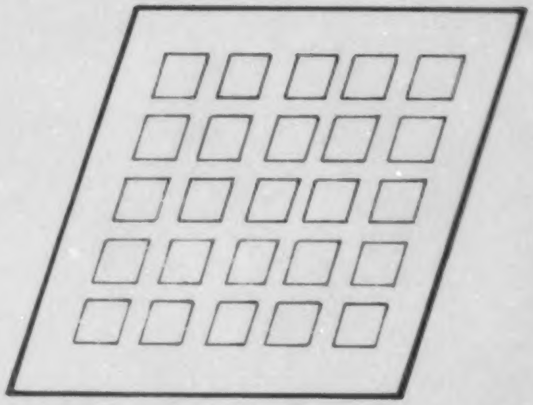
Plastic Deformation



Metal Section Undisturbed

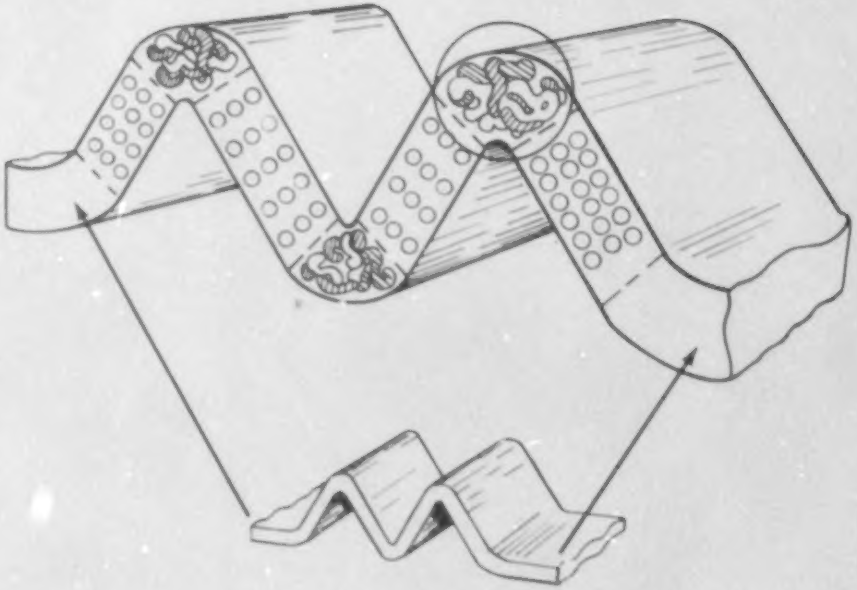


Section Undergoing Severe Distortion

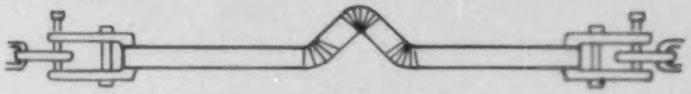


Metal Section Returns Only Part of the Way

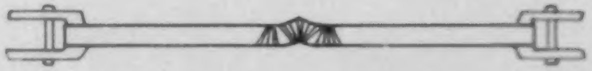
Work Hardening



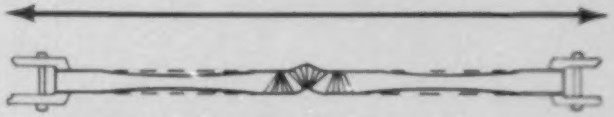
Metal When Bent, Will Cause Severe Locks In The Bend, Called Work Hardening.



Work Hardened Metal Will Refuse

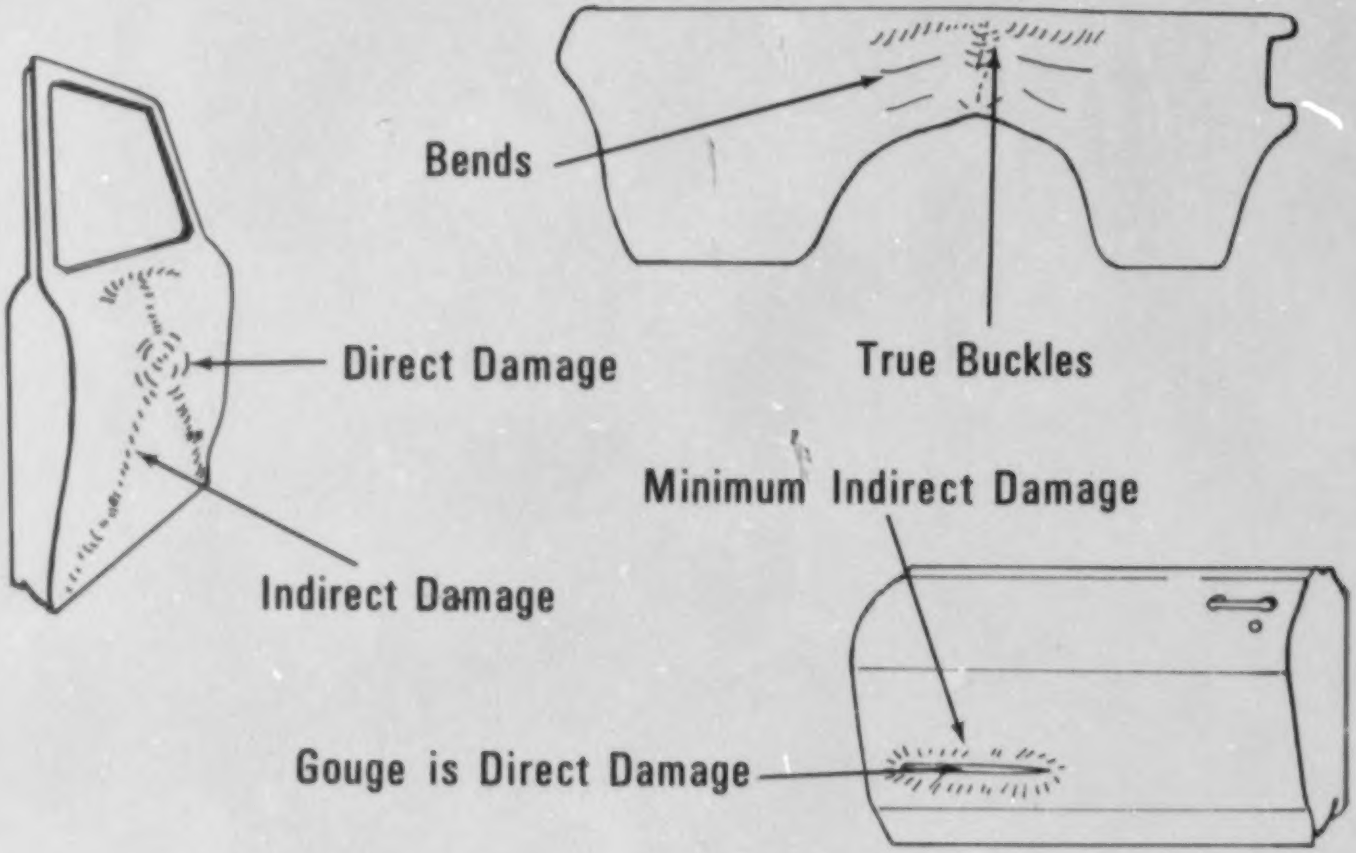


To Yield By Sheer Pulling Force.



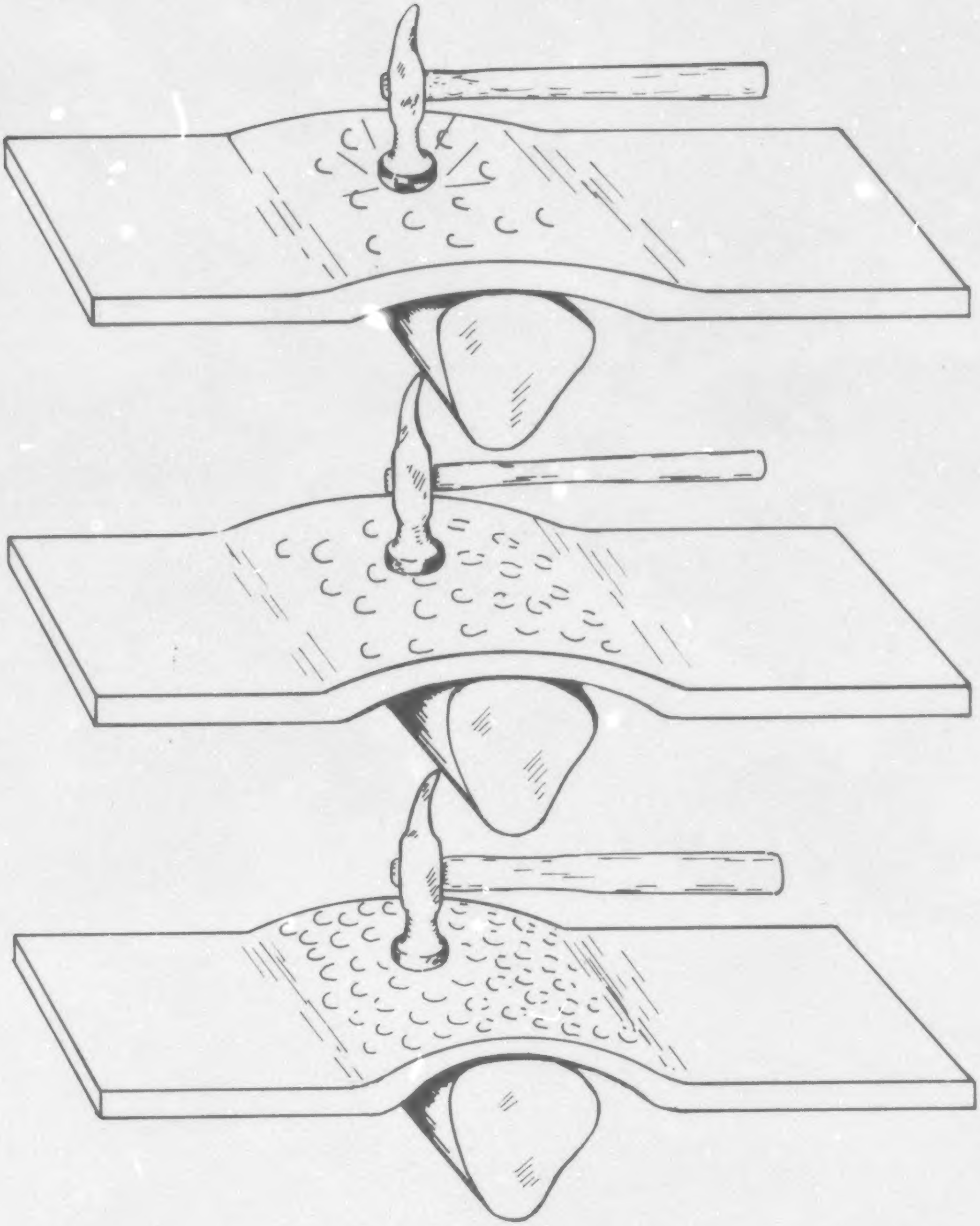
Straight Portions Will Stretch Before Work Hardened Areas Will Yield.

Direct Damage, Indirect Damage, and Direction of Impact



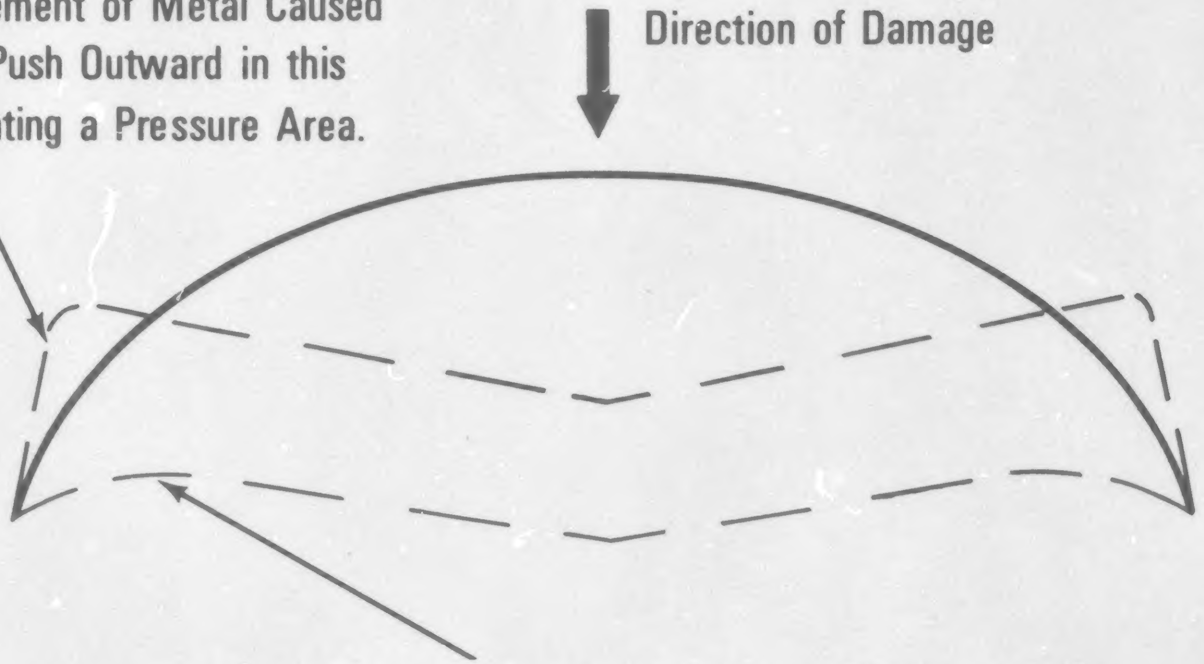
Bends
True Buckles
Direct Damage
Indirect Damage
Minimum Indirect Damage
Gouge is Direct Damage

Stretch



Hard hammer blows continuously will result in stretched and severe work hardening of the metal.

Pressure and Tension

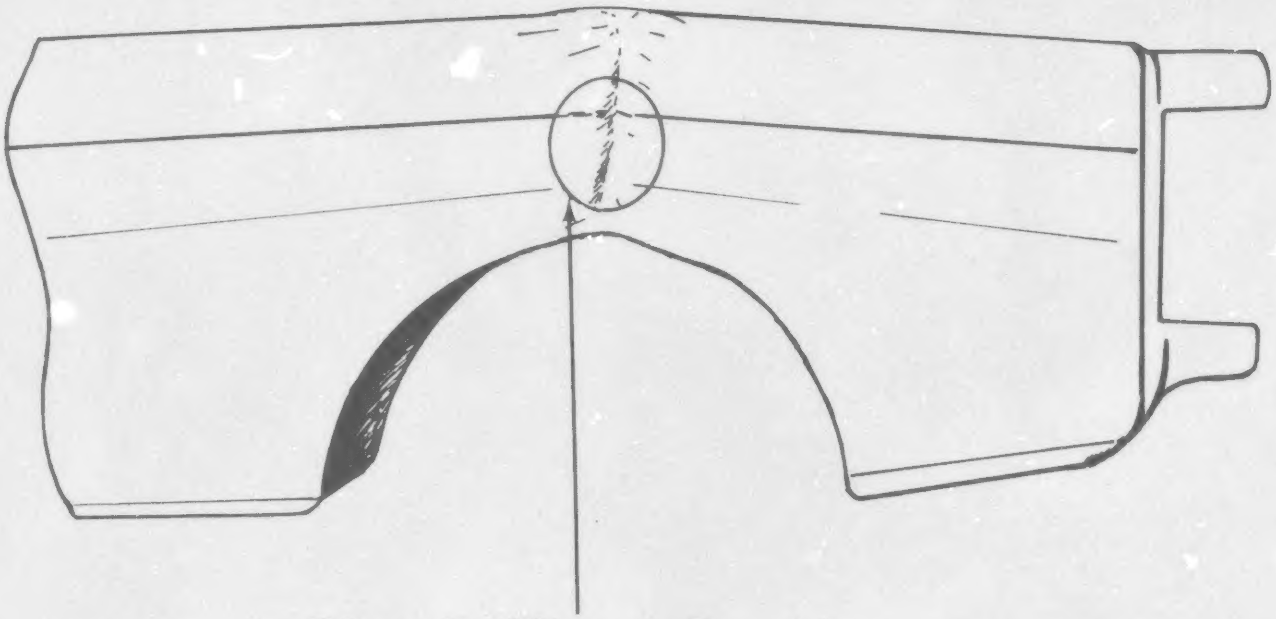


Direction of Damage

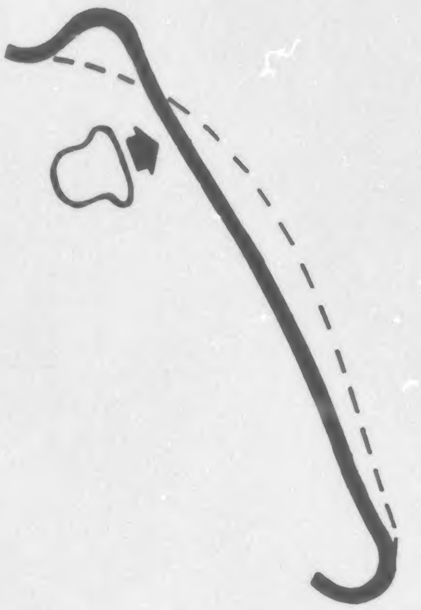
The Movement of Metal Caused Panel to Push Outward in this Area Creating a Pressure Area.

As Damage Extended Further, the Metal Began to Pull Inward. Pressure is Changing to Tension as the Metal has Gone "Through Center."

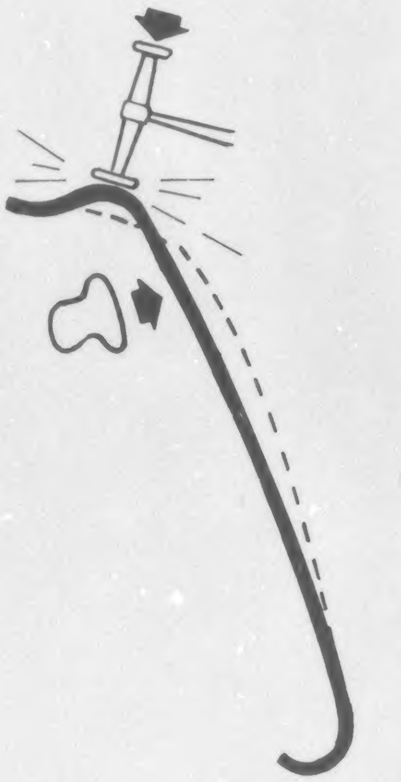
Hinge Buckle


Simple Hinge Buckle

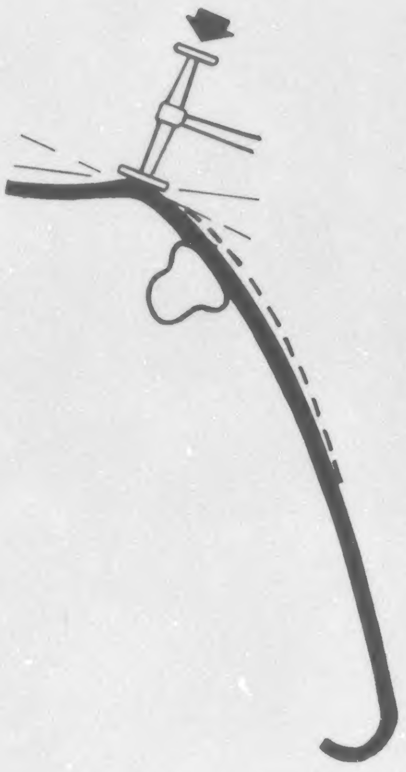
Roll Buckle



Dolly Position for First Rough-Out Blow

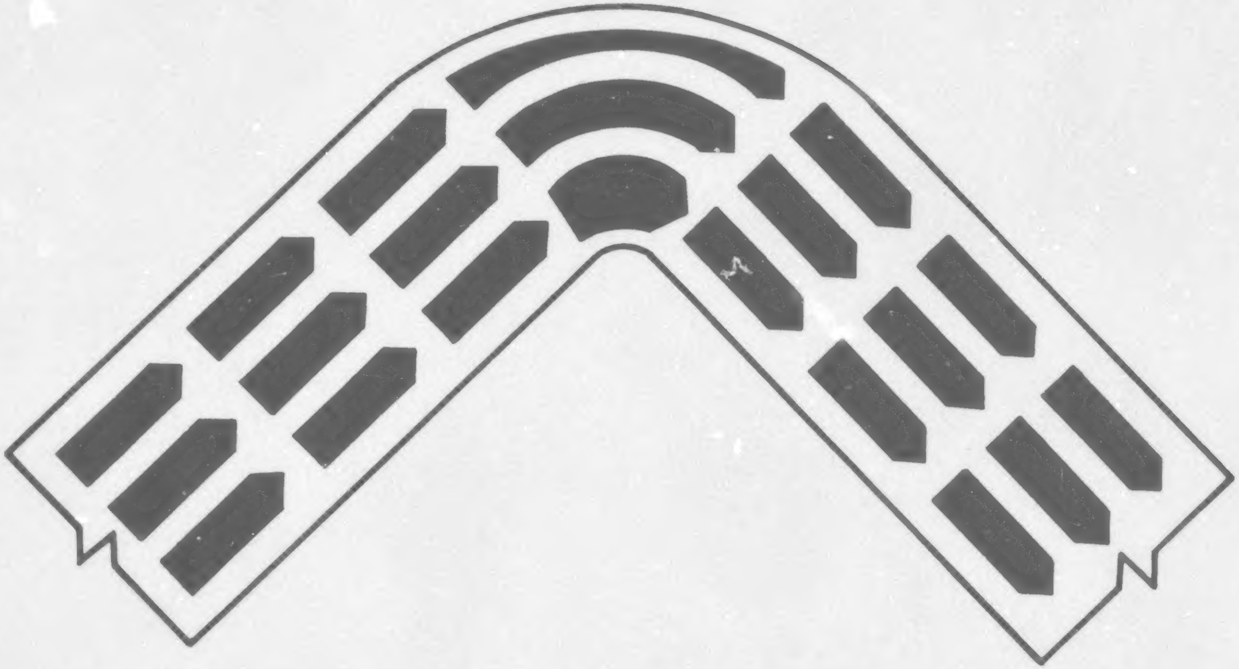


Hammer on High Break-Over Point



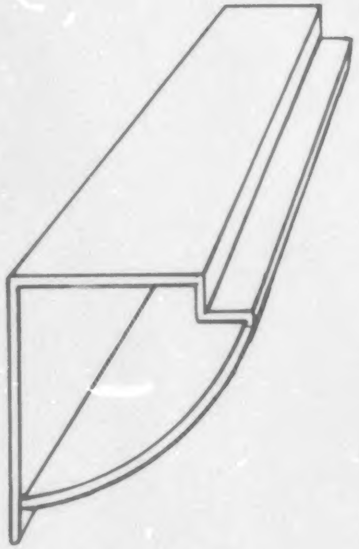
Final Buckle Condition

Effects of Bending Body Sheet Metal

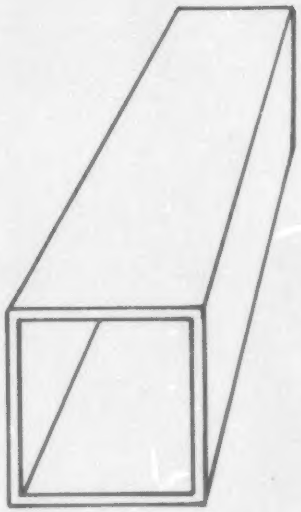


A piece of metal, severely bent, will stretch on the outer edge while the inner edge will become upset and thicker.
The center remains constant.

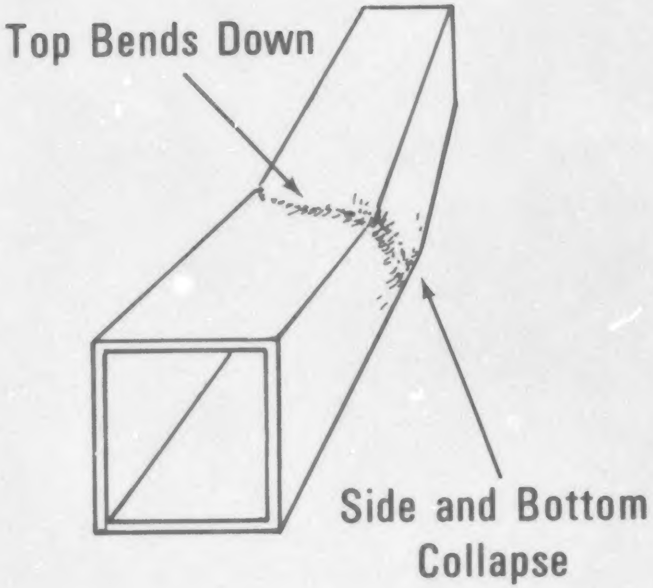
Effects of Bending Hollow (Box Section) Metal



Rocker Panel

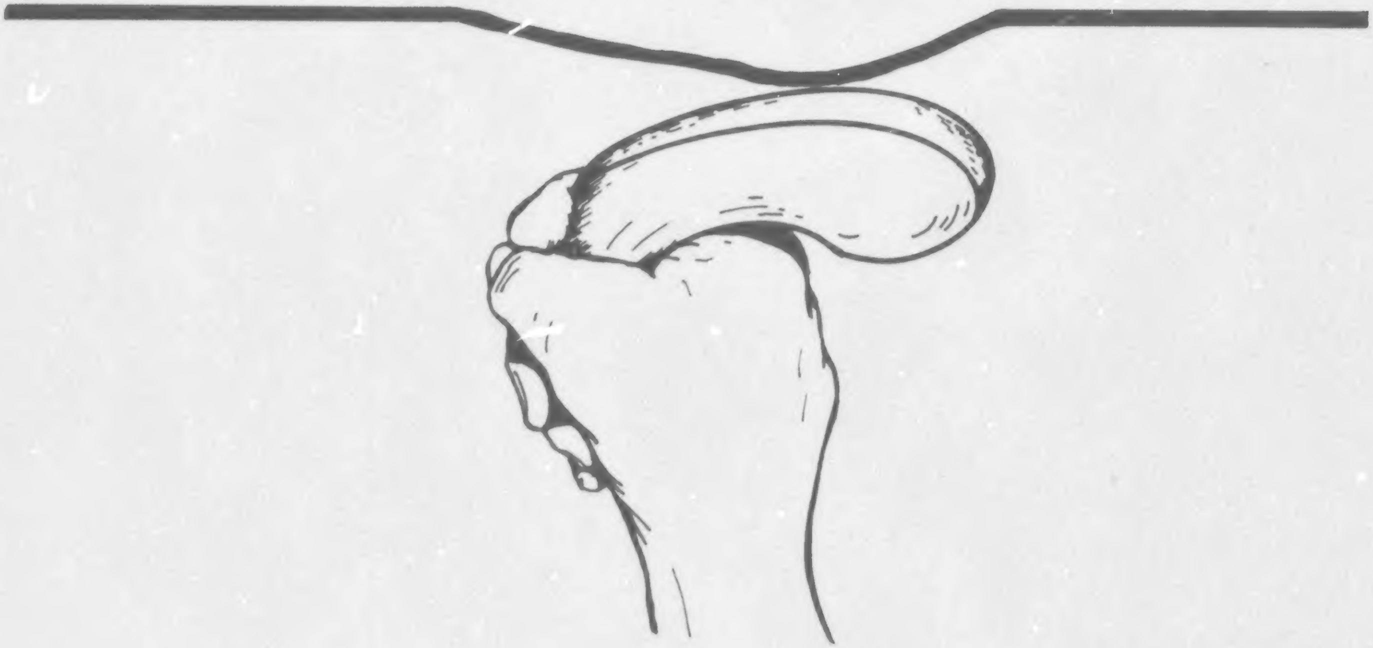


Section Frame Rail

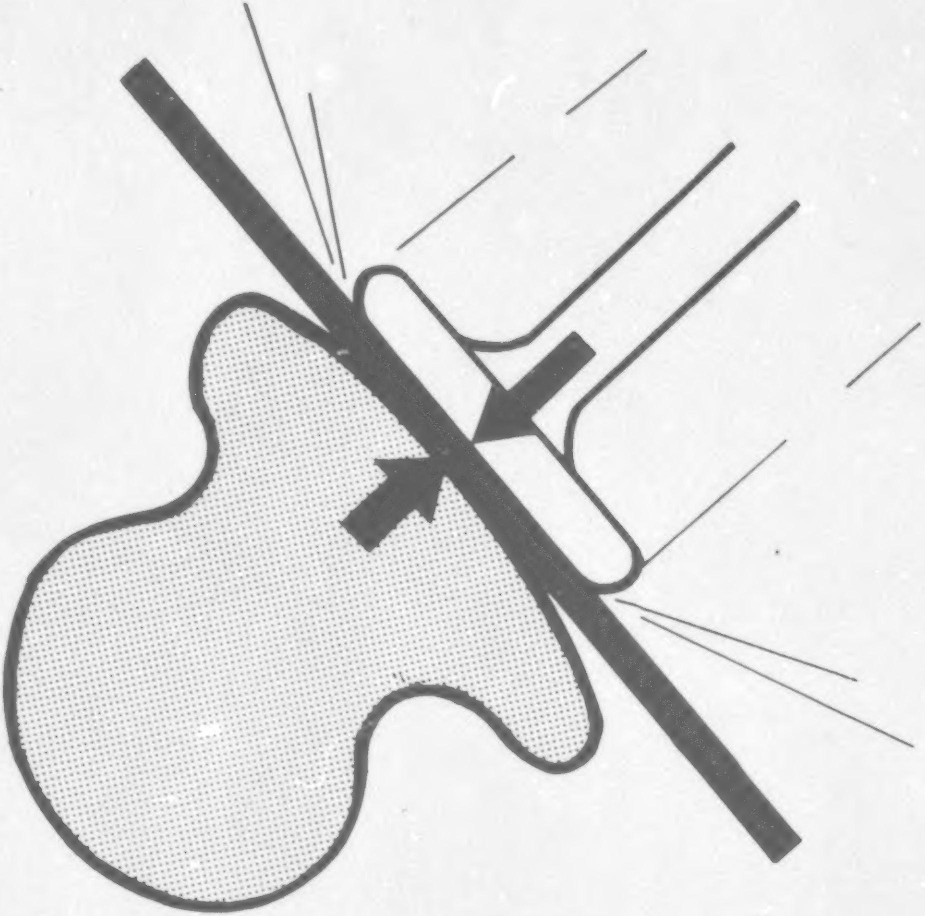

Top Bends Down
Side and Bottom Collapse

Bent Box Section

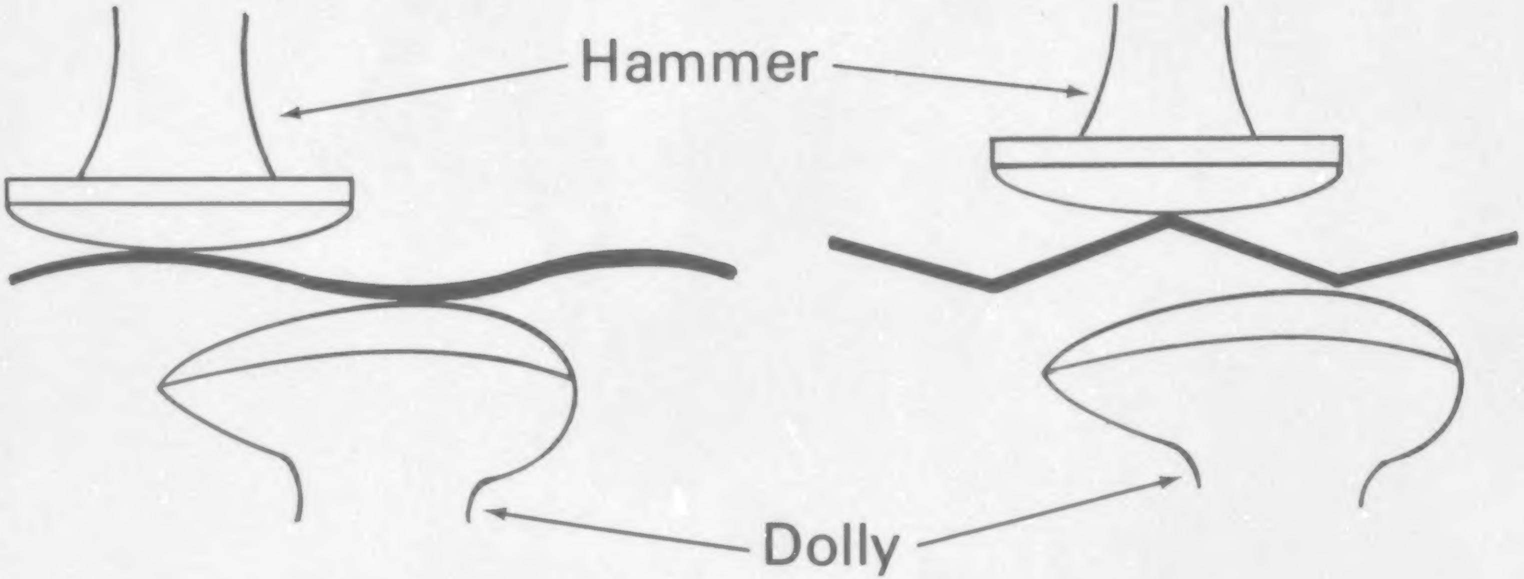
Use of a Dolly in Roughout



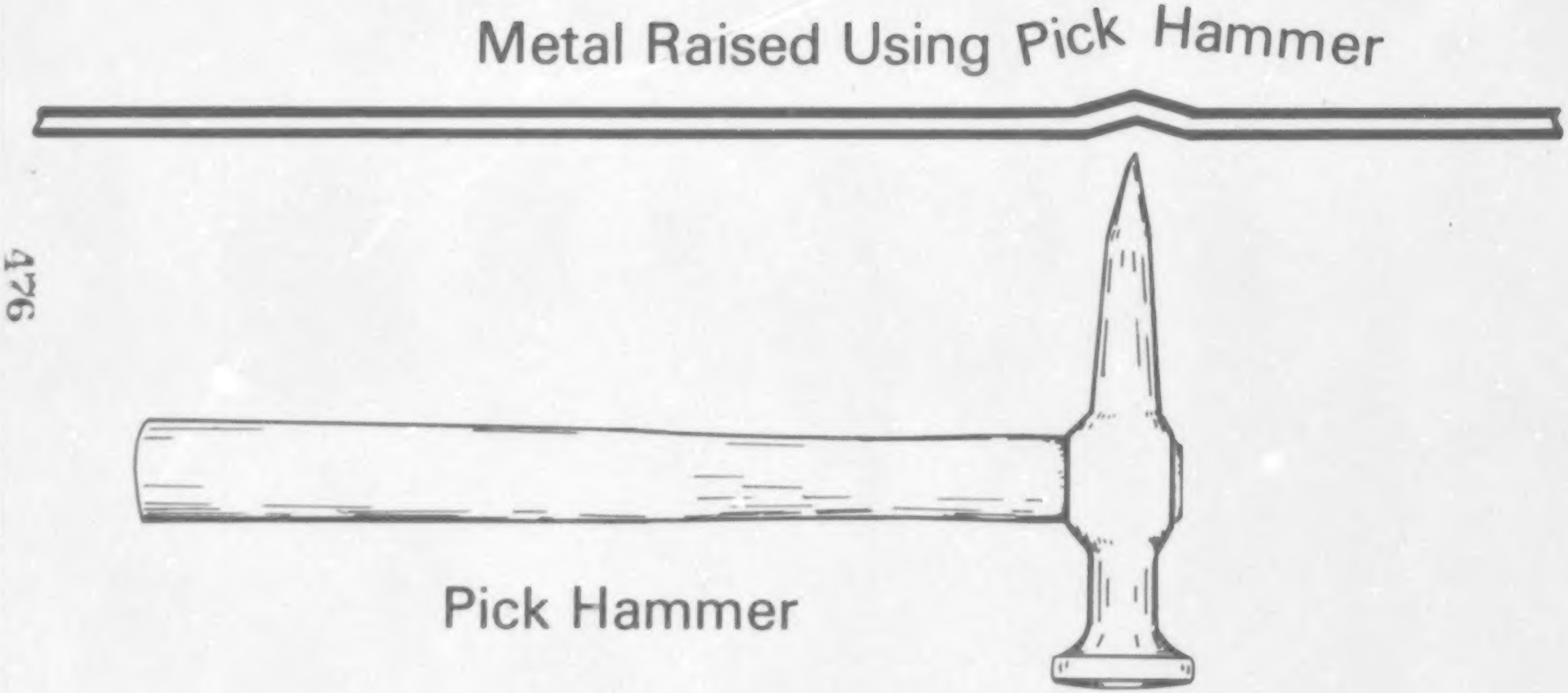
Hammering On the Dolly



Hammering Off the Dolly


Hammer
Dolly

Picking


Metal Raised Using Pick Hammer
Pick Hammer

ROUGHOUT
UNIT II

JOB SHEET #1--ALIGN A HOOD

I. Tools and equipment

   A. Screwdriver

   B. Ratchet 3/8 drive

   C. Sockets 3/8" thru 9/16" by 3/8" drive

   D. Extention 3/8" drive by 6"

   E. Combination wrenches 3/8" thru 9/16"

   F. Steel tape

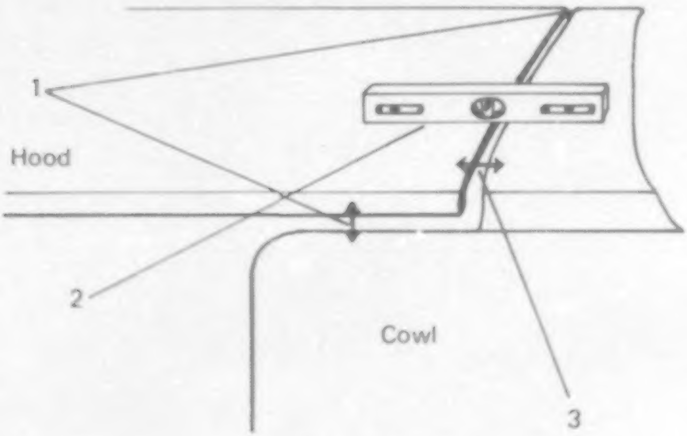
II. Procedure

   A. Work hinges up and down to see they move freely

   B. Replace the hinge if damaged

   C. Lower hood and check clearance along cowl (Figure 1)

FIGURE 1



1. Clearance should be the same on both left and right sides

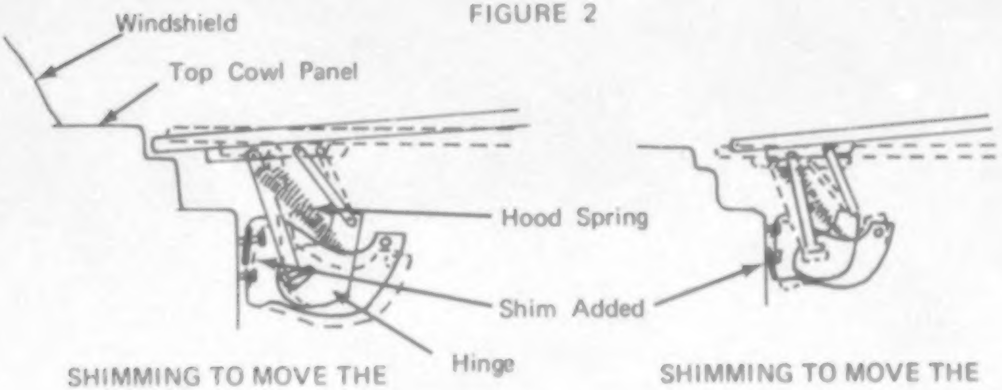
2. Hood should be level with the cowl along the back edge

3. Hood should have the proper clearance between hood and cowl 3/16" ± 1/16"

JOB SHEET #1

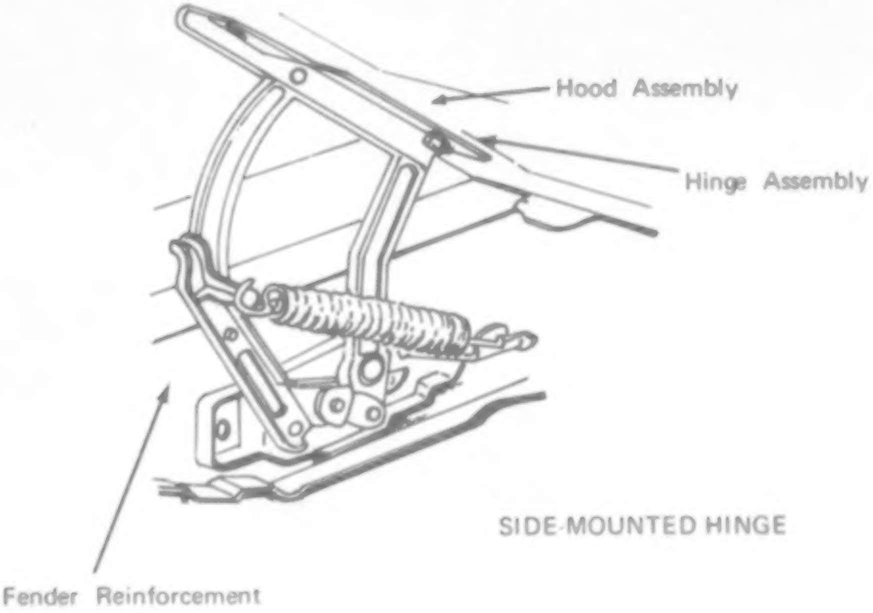
D. Adjust hood to obtain the proper alignment with the cowl as illustrated (Figure 2)

FIGURE 2


Windshield
Top Cowl Panel
Hood Spring
Shim Added
Hinge

SHIMMING TO MOVE THE HOOD UP AND AHEAD

SHIMMING TO MOVE THE HOOD DOWN AND BACK


Hood Assembly
Hinge Assembly
Fender Reinforcement

SIDE-MOUNTED HINGE

ROUGHOUT
UNIT II

JOB SHEET #2--ALIGN A FENDER

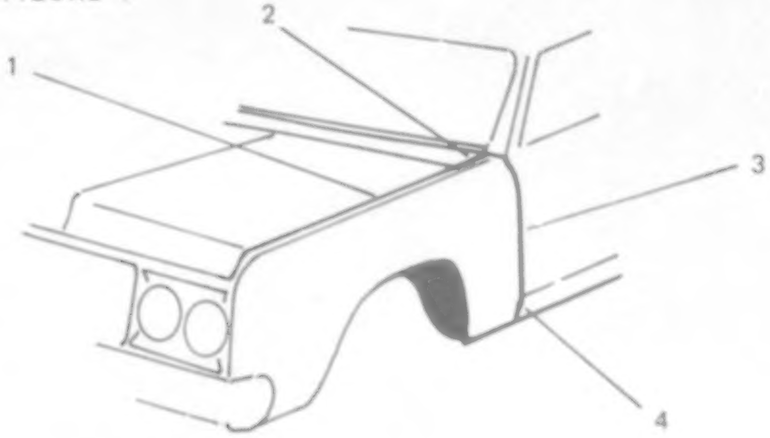
I. Tools and equipment

- A. Screwdriver set
- B. Phillips screwdriver No. 1, No. 2
- C. Ratchet 3/8" drive
- D. Socket 1/4" thru 3/4" by 3/8" drive
- E. Extention 3/8" drive by 3" and 6"
- F. Combination wrenches 3/8" thru 3/4"
- G. Steel tape

II. Procedure

- A. Check clearances (Figure 1)

FIGURE 1



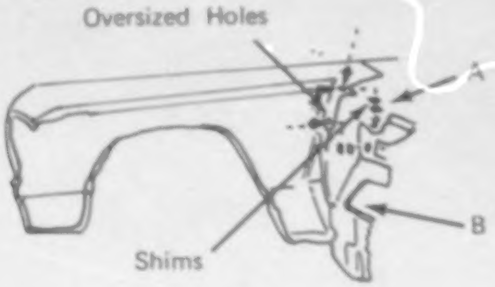
1. Hood 3/16" ± 1/16"
2. Cowl 3/16" ± 1/16"
3. Door 3/16" ± 1/16"
4. Rocker panel 3/16" ± 1/16"

JOB SHEET #2

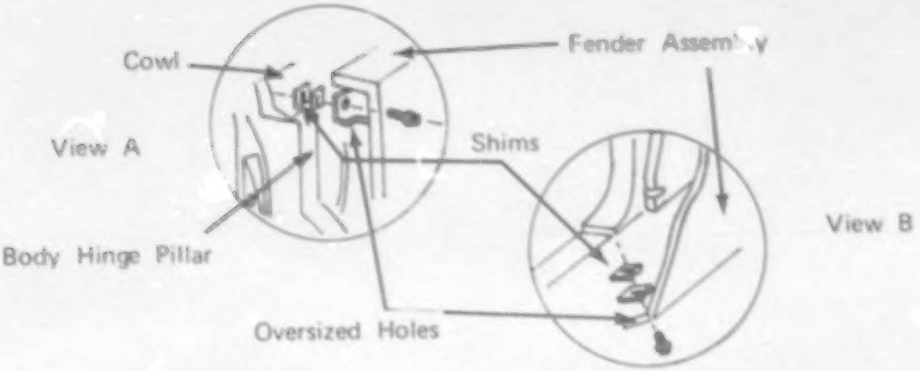
B. Adjust fender

1. Move the fender forward and backward (Figure 2)

FIGURE 2


Oversized Holes
A
B
Shims

FRONT FENDER FORWARD AND BACK ADJUSTMENTS


Cowl
Fender Assembly
View A
Shims
View B
Body Hinge Pillar
Oversized Holes

a. Loosen the bolts at the radiator support, along the inner fender, and at the top and bottom of the cowl

b. Move the fender to desired position

(NOTE: A pry bar or body jack might have to be used to provide pressure.)

c. Place shims in necessary location

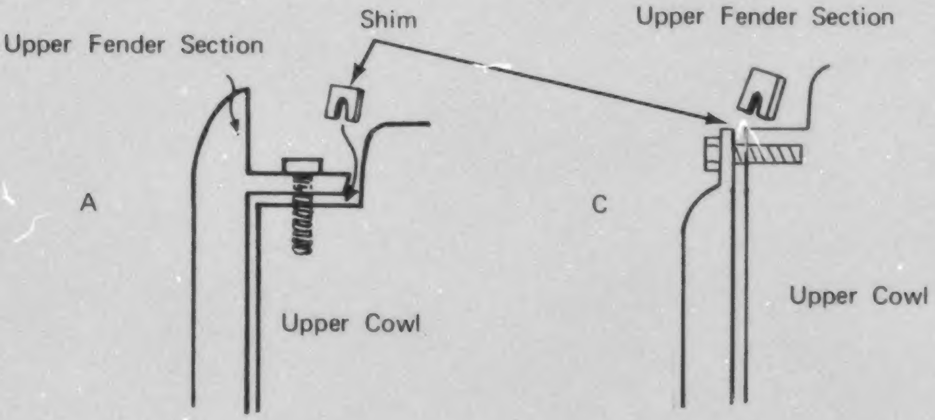
Example: Between cowl and fender

d. Tighten all bolts

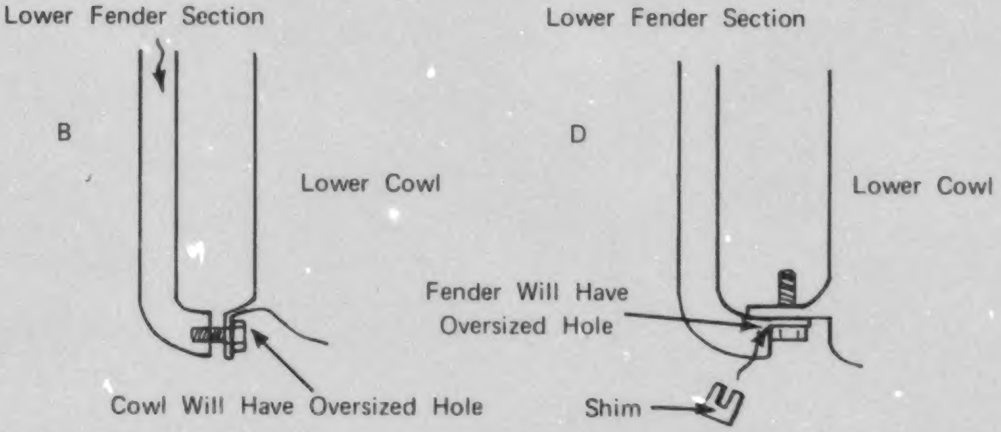
JOB SHEET #2

2. Move the fender up and down (Figure 3)

FIGURE 3


Upper Fender Section
Shim
Upper Fender Section
A
C
Upper Cowl
Upper Cowl

Add Shims to Raise
Remove Shims to Lower


Lower Fender Section
Lower Fender Section
B
D
Lower Cowl
Lower Cowl
Fender Will Have Oversized Hole
Cowl Will Have Oversized Hole
Shim

Loosen Only to Raise or Lower

Add Shims to Lower
Remove Shims to Raise

a. Loosen the bolts in the cowl area

(NOTE: It may be necessary to loosen bolts in the inner fender.)

JOB SHEET #2

b. Add or remove shims at the bottom of the cowl

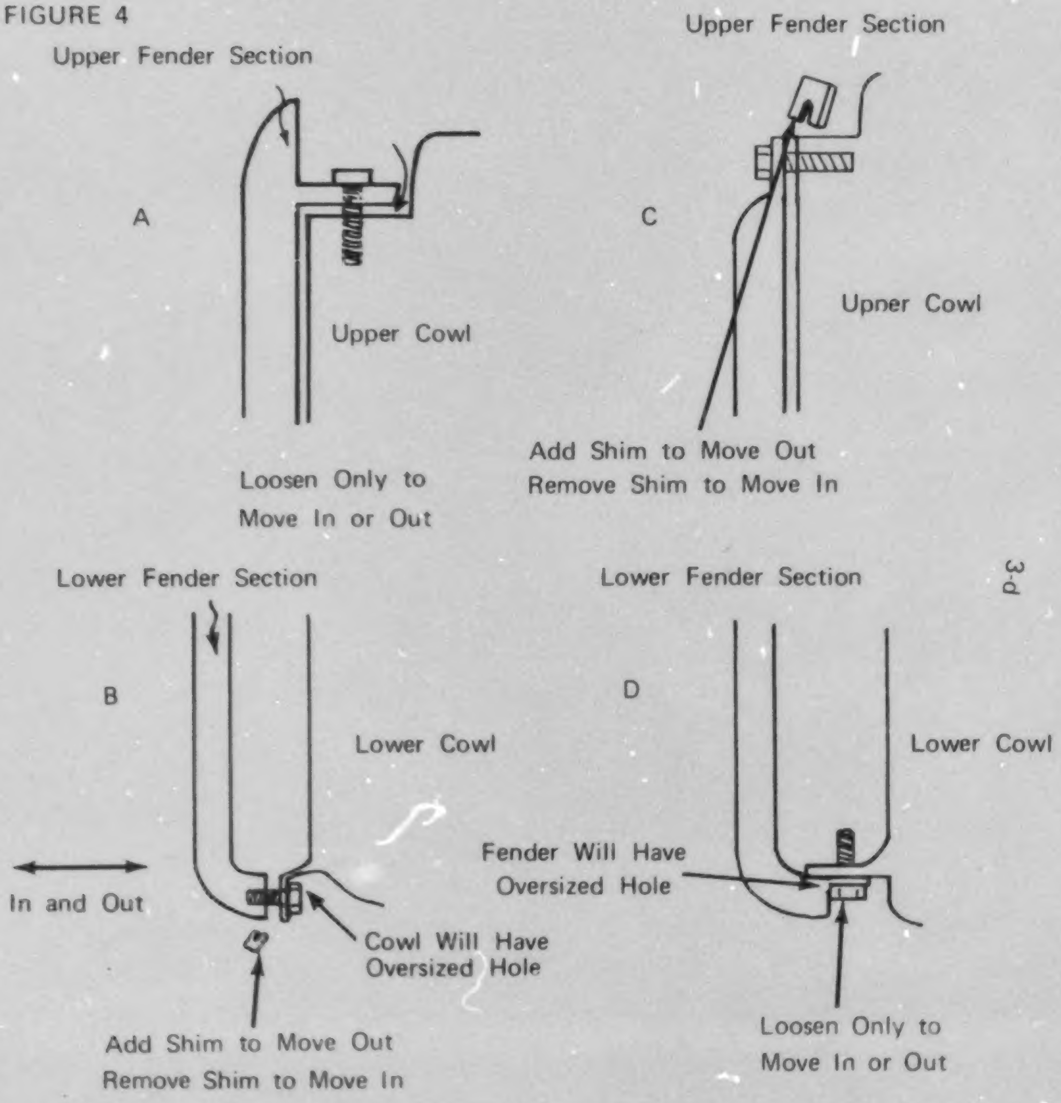
(NOTE: If fender is bolted vertically, loosen bolts only and move up or down.)

c. Add or remove shims to top of the cowl

(NOTE: If fender is bolted vertically, loosen bolts only and move up or down.)

3. Move the fender in and out (Figure 4)

FIGURE 4


Upper Fender Section
A
Upper Cowl
Loosen Only to
Move In or Out
Upper Fender Section
C
Upner Cowl
Add Shim to Move Out
Remove Shim to Move In
Lower Fender Section
B
Lower Cowl
In and Out
Cowl Will Have
Oversized Hole
Add Shim to Move Out
Remove Shim to Move In
Lower Fender Section
D
Lower Cowl
Fender Will Have
Oversized Hole
Loosen Only to
Move In or Out

3-d

JOB SHEET #2

a. Loosen the bolts in the cowl area

b. Add or remove shims at the bottom of the cowl

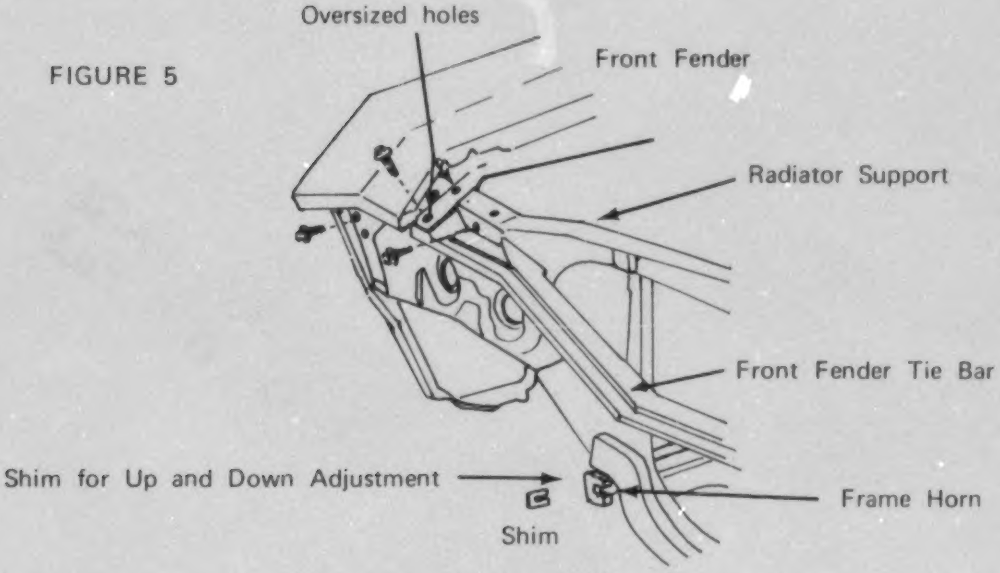
(NOTE: If fender is bolted horizontally, loosen bolt only and move in or out.)

c. Add or remove shims at the top of the cowl

(NOTE: If fender is bolted horizontally, loosen bolts only and move in or out.)

4. Front section adjustments (Figure 5)

FIGURE 5


Oversized holes
Front Fender
Radiator Support
Front Fender Tie Bar
Shim for Up and Down Adjustment
Frame Horn
Shim

FRONT FENDER, IN-AND-OUT, AND UP-AND-DOWN ADJUSTMENTS

a. Loosen bolts where fender is attached to the radiator support

b. Add or remove shims if bolted horizontally to move fender up or down

c. Add or remove shims to the radiator support bolt to move fender up or down

d. Add or remove shims to vertical bolted area to move fender in or out

C. Check clearance gap between door, cowl, and hood 3/16" ± 1/16"

ROUGHOUT
UNIT II

JOB SHEET #3--ALIGN A HEADLIGHT ASSEMBLY

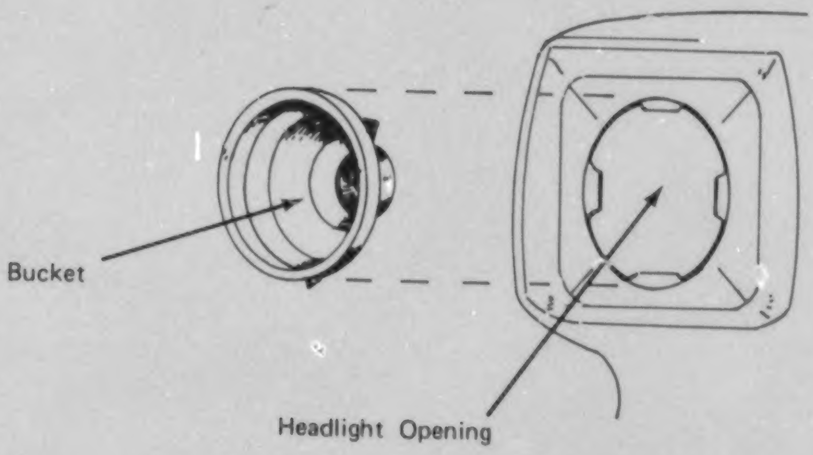
I. Tools and equipment

- A. Screwdriver
- B. Phillips screwdriver No. 1, No. 2
- C. Ratchet 1/4" drive
- D. Socket 1/4" thru 3/8" by 1/4" drive
- E. Extension 1/4" drive by 6"
- F. Headlight alignment equipment

II. Procedure

- A. Check bucket clearance with fender opening (Figure 1)

FIGURE 1

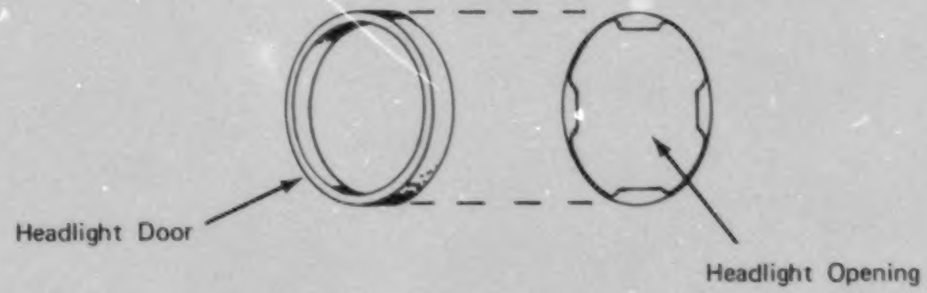


1. Use hammer and dolly to shape fender to bucket
2. Weld breaks in opening

JOB SHEET #3

B. Align headlight door to fender (Figure 2)

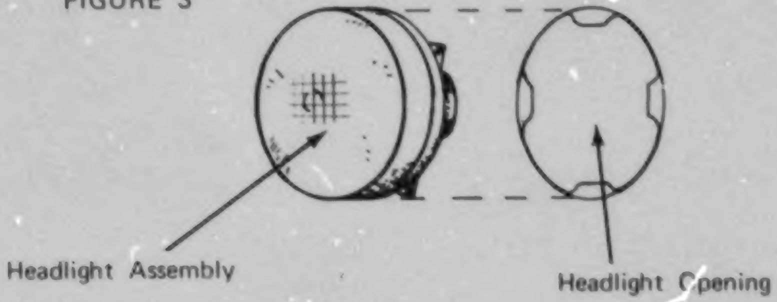
FIGURE 2


Headlight Door
Headlight Opening

1. Use hammer and dolly to shape fender to headlight door
2. Shrink stretched areas

C. Install headlight assembly to insure proper alignment with fender as illustrated (Figure 3)

FIGURE 3


Headlight Assembly
Headlight Opening

(NOTE: Aim and align headlights at this point.)

ROUGHOUT
UNIT II

JOB SHEET #4--ALIGN A BUMPER

I. Tools and equipment

   A. Screwdriver

   B. Phillips screwdriver No 2

   C. Ratchet 1/2 drive

   D. Break over 1/2 drive

   E. Socket 9/16" thru 7/8" by 1/2 drive

   F. Combination wrenches 9/16" thru 13/16"

II. Procedure

   A. Check clearances

      1. Grill, stone deflector, lower deck panel

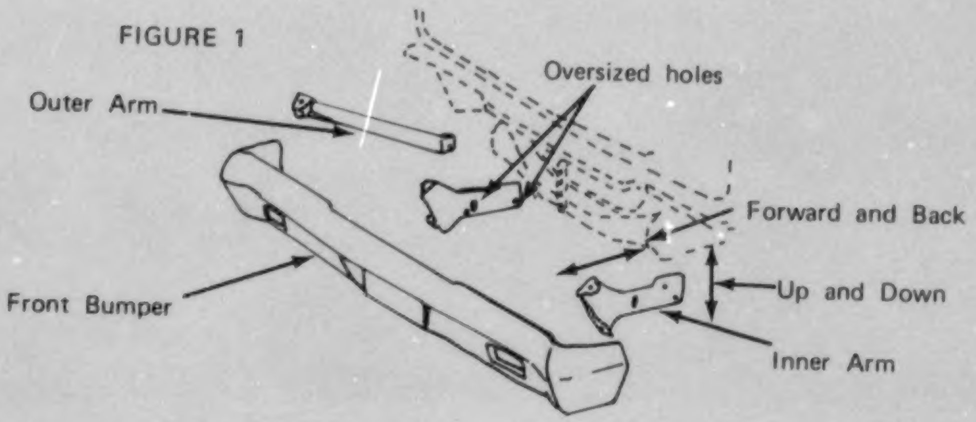
      2. Fender gap, quarter panel gap

      3. Level

   B. Adjust bumpers as illustrated (Figures 1, 2, and 3)(Continued next page)

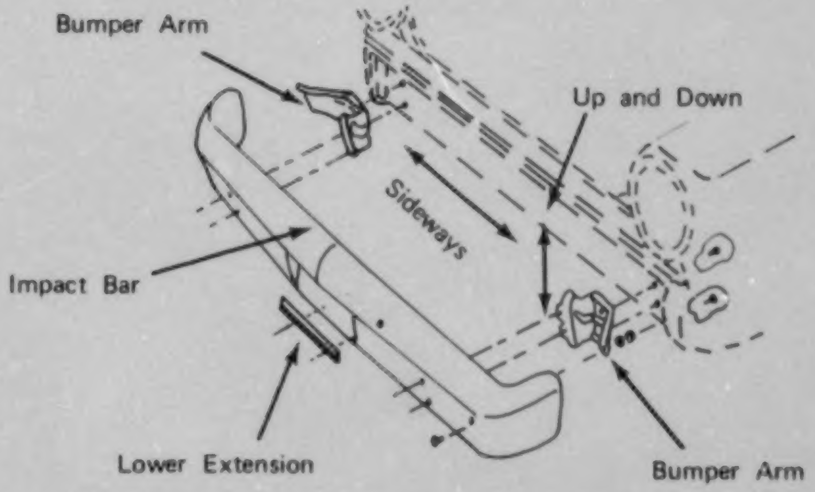
   (DANGER: On energy absorbing bumpers, check procedure or service manual before removing bumper as inclosed high tension spring could cause death or bodily injury.)

FIGURE 1

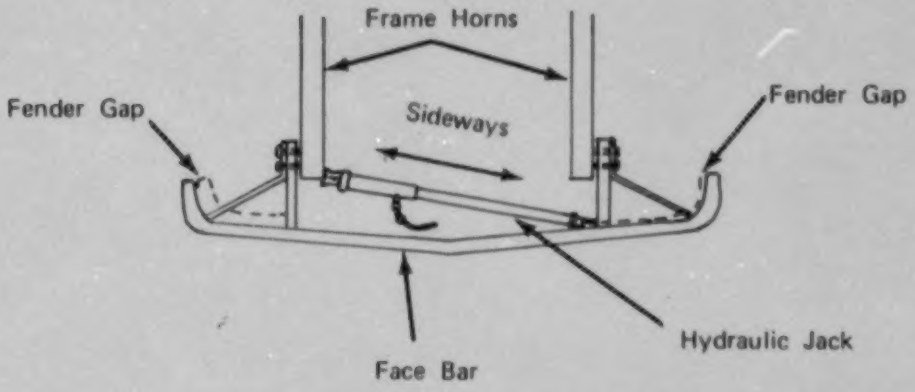

Outer Arm
Oversized holes
Forward and Back
Up and Down
Front Bumper
Inner Arm

TYPICAL BUMPER AND-ARM SUPPORT ASSEMBLY

JOB SHEET #4


Bumper Arm
Up and Down
Sideways
Impact Bar
Lower Extension
Bumper Arm

REAR BUMPER SUPPORT-TO-FRAME MOUNT


Frame Horns
Fender Gap
Sideways
Fender Gap
Hydraulic Jack
Face Bar

ADJUSTING THE BUMPER SIDE FIT

ROUGHOUT
UNIT II

JOB SHEET #5--ALIGN A DOOR

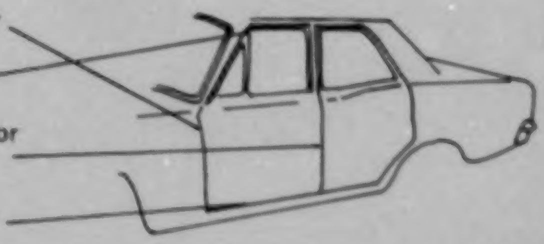
I. Tools and equipment

- A. Screwdriver
- B. Phillips screwdriver No. 2, No. 3
- C. Ratchet 1/2 drive
- D. Socket 1/2" thru 11/16" by 1/2 drive
- E. Extension 1/2 drive by 6"
- F. Hand impact tool 1/2 drive
- G. Ball peen hammer 3 lb.
- H. Door hinge wrenches
- I. Door striker (torx driver) wrench
- J. Wood block
- K. Steel rule
- L. 10 ton hydraulic jack set

II. Procedure

- A. Check clearance (Gap 3/16 ± 1/16 by measuring) as illustrated (Figure 1)
  1. Door to fender
  2. Door to top
  3. Door to door or quarter panel
  4. Door to rocker panel

FIGURE 1

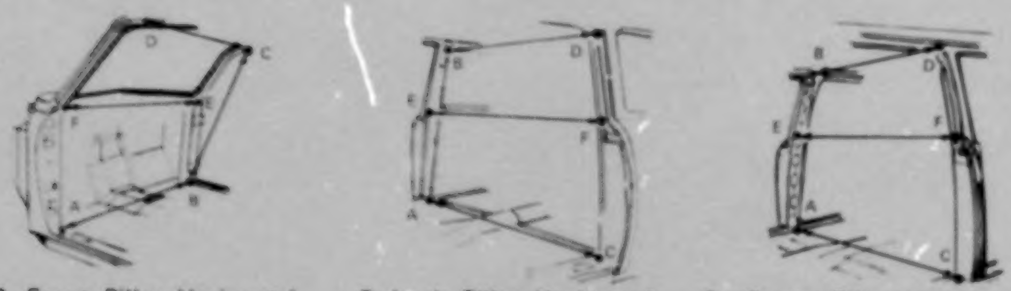


(NOTE: Door must be level to adjacent panels.)

JOB SHEET #5

B. Check the door opening for square by measuring and checking measurement with specifications (Figure 2)

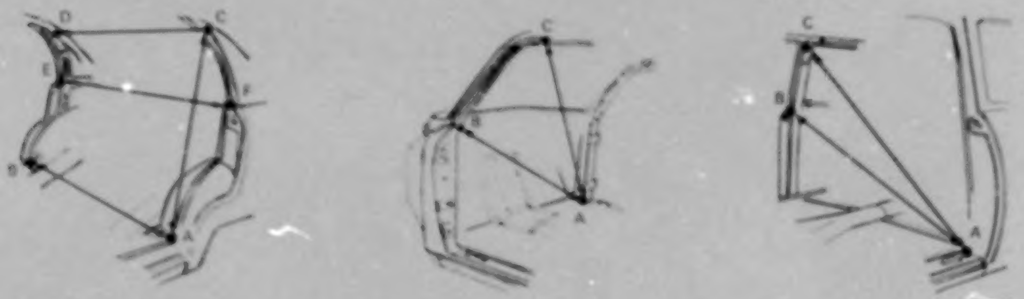
FIGURE 2



A Front Pillar Horizontal and Vertical Measuring Points

B Lock Pillar Horizontal and Vertical Measuring Points

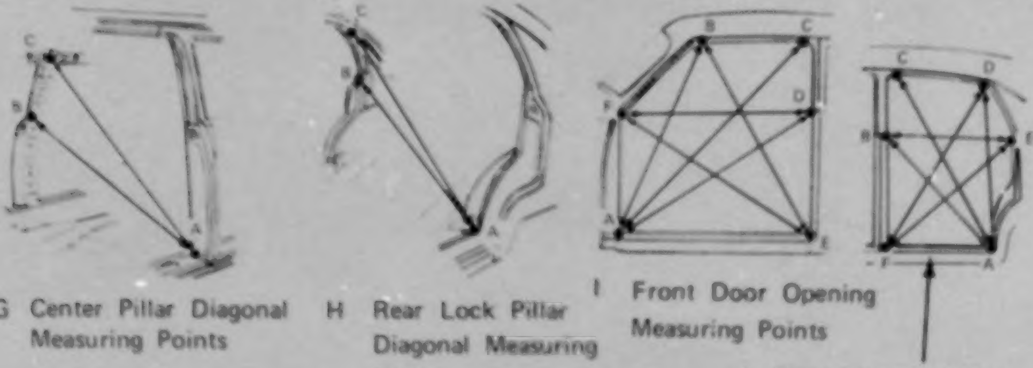
C Center Pillar Horizontal and Vertical Measuring Points



D Rear Lock Pillar Horizontal and Vertical Measuring Points

E Front Pillar Diagonal Measuring Points

F Lock Pillar Diagonal Measuring Points



G Center Pillar Diagonal Measuring Points

H Rear Lock Pillar Diagonal Measuring Points

I Front Door Opening Measuring Points

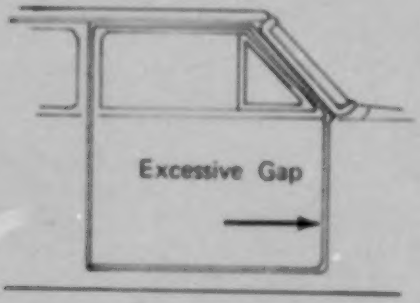
J Rear Door Opening Measuring Points

JOB SHEET #5

C. Adjust door as illustrated (Figures 3, 4, 5, 6, and 7)

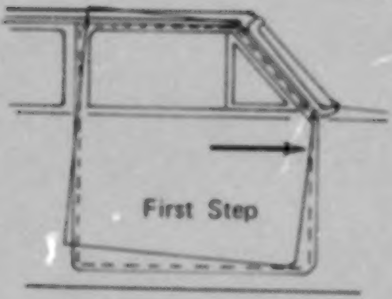
D. Check for wind and water leaks

FIGURE 3

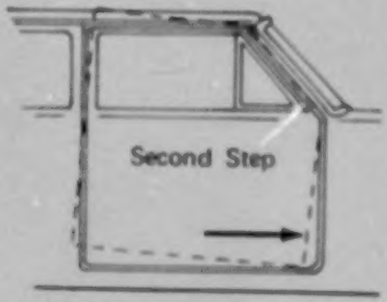

Excessive Gap

MOVING THE DOOR FORWARD

A



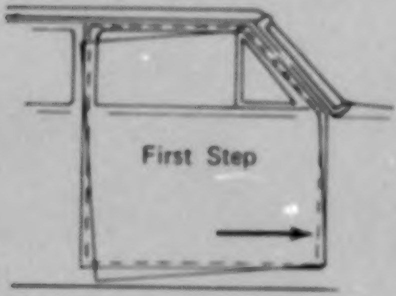
Move the Door Ahead
at the Top Hinge


Second Step

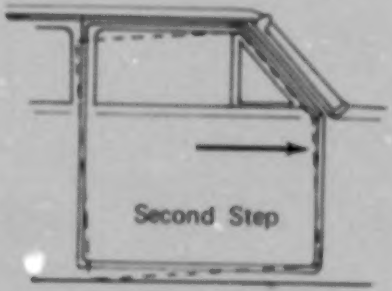
Move the Door Ahead
at the Bottom Hinge

OR

B



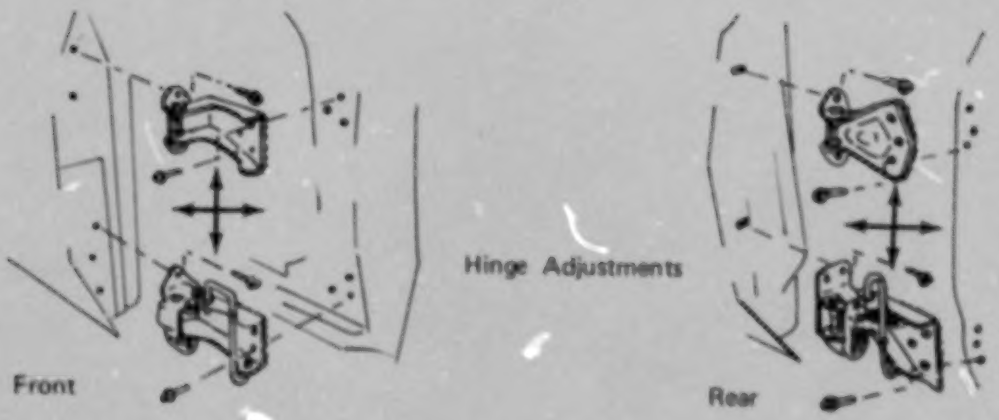
Move the Door Ahead
at the Bottom Hinge


Second Step

Move the Door Ahead
at the Top Hinge

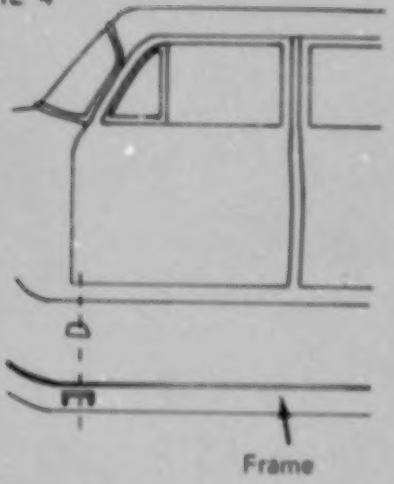
JOB SHEET #5

FIGURE 3 (Continued)


Hinge Adjustments
Front
Rear

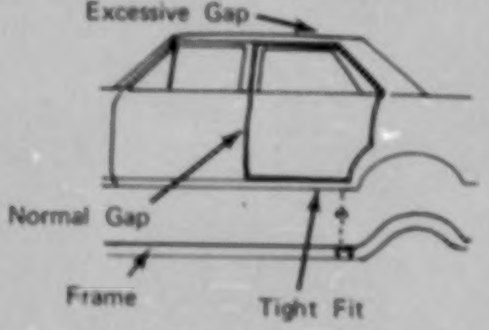
USING AVAILABLE HINGE BOLT ADJUSTMENT

FIGURE 4

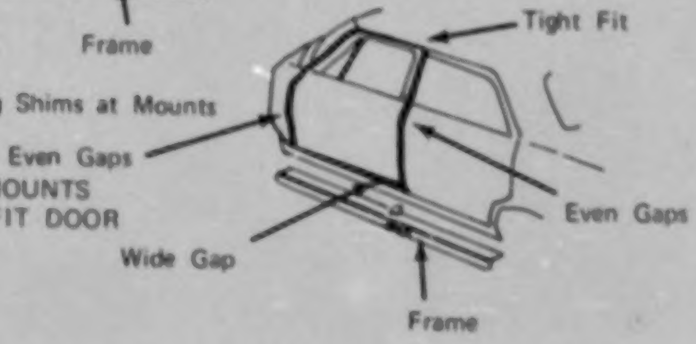


Adding Shims at Mounts

BODY FRAME ADJUSTMENTS
TO CORRECT DOOR ALIGNMENT


Excessive Gap
Normal Gap
Frame
Tight Fit

Removing Shims

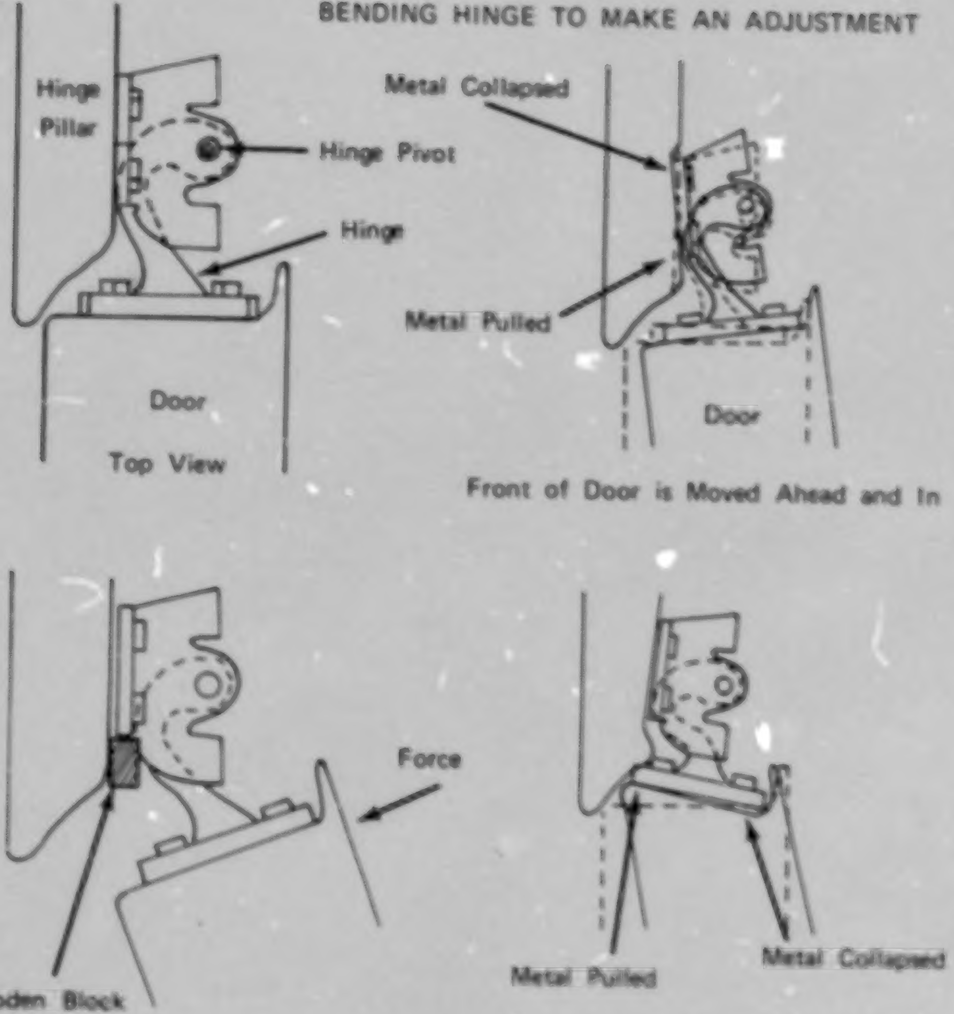

Tight Fit
Even Gaps
Even Gaps
Wide Gap
Frame

USE SHIMS AT BODY MOUNTS
TO ADJUST BODY TO FIT DOOR

JOB SHEET #5

FIGURE 5

BENDING HINGE TO MAKE AN ADJUSTMENT

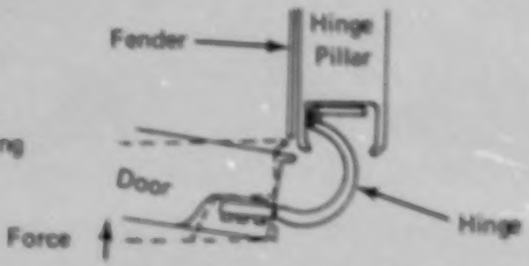

Hinge Pillar
Hinge Pivot
Hinge
Door
Top View
Metal Collapsed
Metal Pulled
Door
Front of Door is Moved Ahead and In
Force
Wooden Block
Metal Pulled
Metal Collapsed

Bringing the Front of the Door Back and Out

Front of Door is Moved In

FIGURE 6

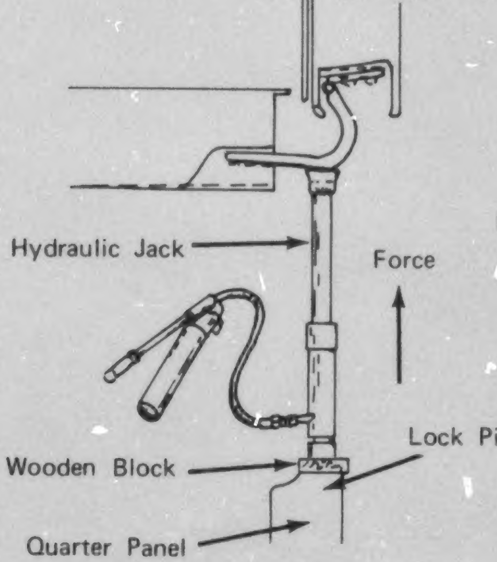
Straightening the Door Hinge-Mounting Metal Using Hydraulic Jack


Fender
Hinge Pillar
Door
Hinge
Force

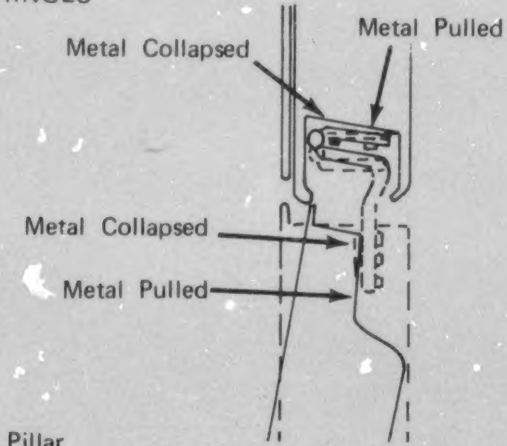
JOB SHEET #5

FIGURE 6 (Continued)

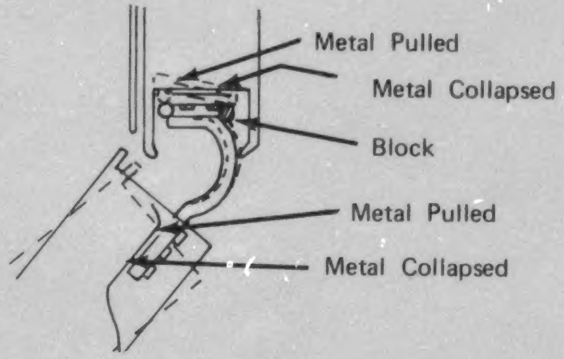
DOOR ADJUSTMENT USING HYDRAULIC JACK TO BEND HINGES


Hydraulic Jack
Force
Wooden Block
Lock Pillar
Quarter Panel

Using a Hydraulic Jack to Correct the Door Fit


Metal Collapsed
Metal Pulled
Metal Collapsed
Metal Pulled

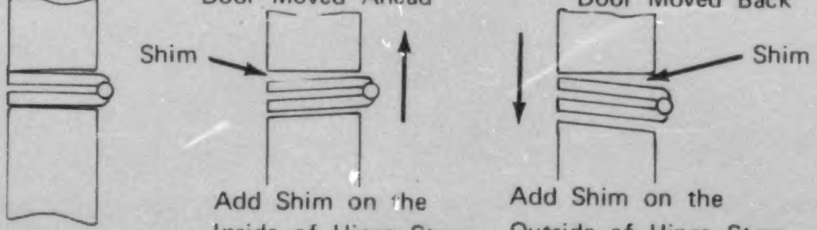
Misalignment Caused by Door Being Forced Open or Driven Ahead


Metal Pulled
Metal Collapsed
Block
Metal Pulled
Metal Collapsed

Realigning the Door by Placing a Block in the Back of the Door in the Hinge

FIGURE 7

DOOR ADJUSTMENT USING SHIMS TO ADJUST HINGES



Before

Hinge Pivot and Door Moved Ahead

Add Shim on the Inside of Hinge Strap

Hinge Pivot and Door Moved Back

Add Shim on the Outside of Hinge Strap

ROUGHOUT
UNIT II

JOB SHEET #6--ALIGN A DECK LID

I. Tools and equipment

   A. Ratchet 3/8 drive

   B. Socket 1/2" thru 5/8" by 3/8" drive

   C. Extention 3/8" drive by 3"

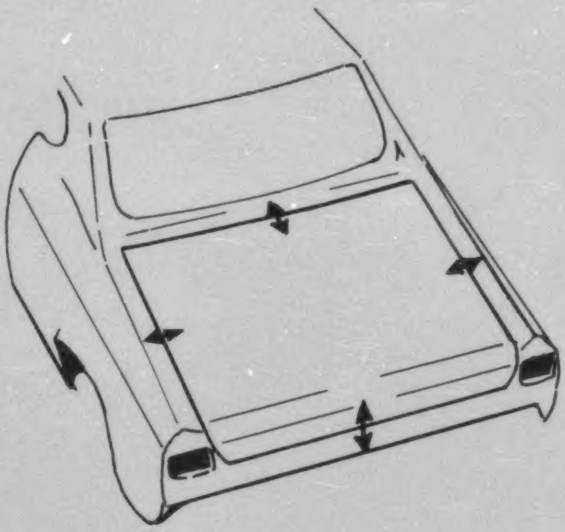
   D. Wood block

   E. Hydraulic jack set

II. Procedure

   A. Check clearance (Figure 1)

FIGURE 1

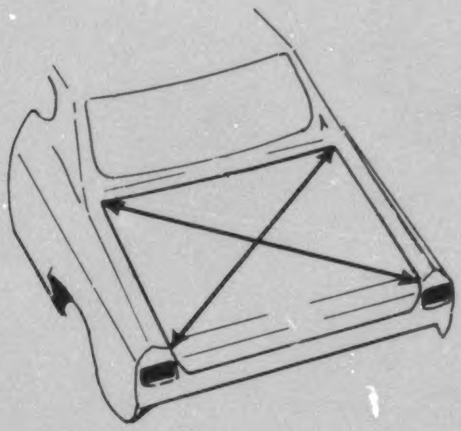


JOB SHEET #6

B. Square opening (Figure 2)

1. Check diagonal measurement
2. Place deck lid in opening to insure proper gap clearance

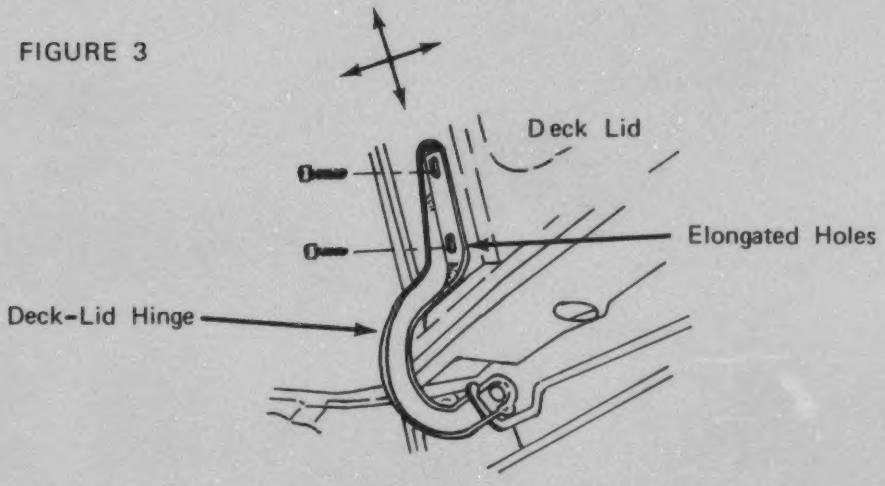
FIGURE 2



C. Adjust deck lid to obtain proper fit

1. Forward, back, sideways as illustrated (Figure 3)

FIGURE 3

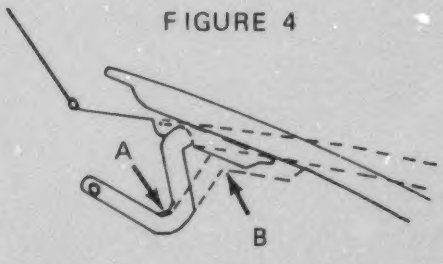

Deck Lid
Elongated Holes
Deck-Lid Hinge

DECK LID ADJUSTMENT LOCATIONS

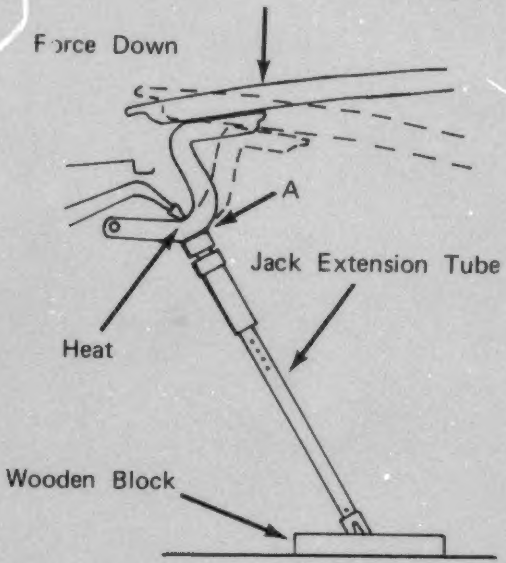
JOB SHEET #6

2. Lowering and raising at hinge as illustrated (Figures 4 and 5)

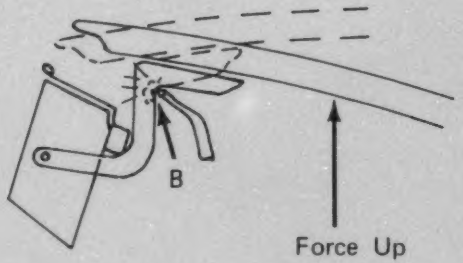
FIGURE 4



The Deck-Lid Hinge Has Bent at A and B (dashes indicate original position)


Force Down
A
Jack Extension Tube
Heat
Wooden Block

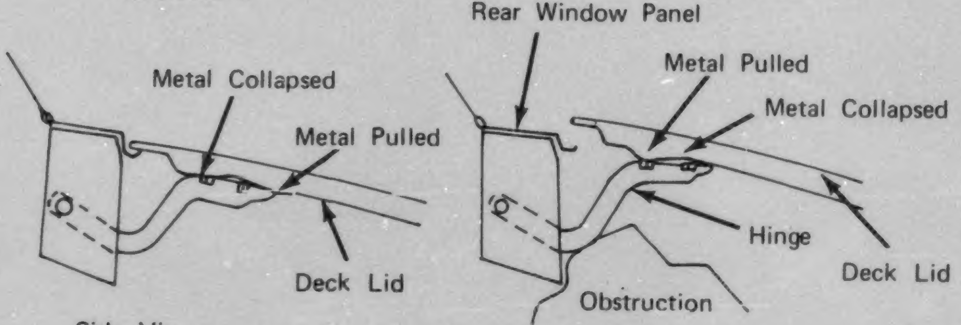
Bending the Deck-Lid Hinge at A



Bending the Deck-Lid Hinge at B

ADJUSTING DECK LID BY USE OF HYDRAULIC JACK AND BLOCK TO BIND HINGE

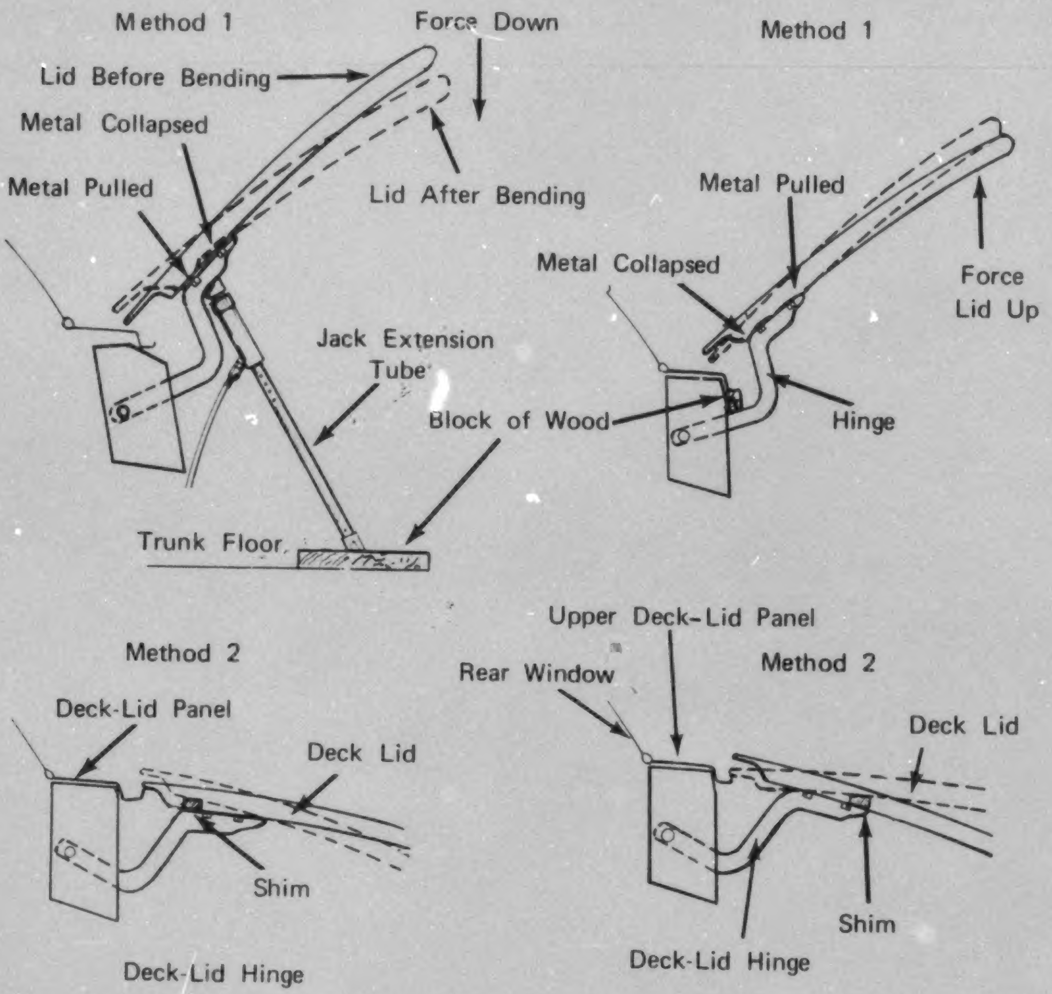
FIGURE 5


Metal Collapsed
Metal Pulled
Deck Lid
Rear Window Panel
Metal Pulled
Metal Collapsed
Hinge
Deck Lid
Obstruction

Side View

Side View

FIGURE 5 (Continued)


Method 1
Force Down
Lid Before Bending
Metal Collapsed
Metal Pulled
Lid After Bending
Jack Extension Tube
Block of Wood
Trunk Floor
Method 1
Metal Pulled
Force Lid Up
Metal Collapsed
Hinge
Method 2
Deck-Lid Panel
Deck Lid
Shim
Deck-Lid Hinge
Upper Deck-Lid Panel
Rear Window
Method 2
Deck Lid
Shim
Deck-Lid Hinge

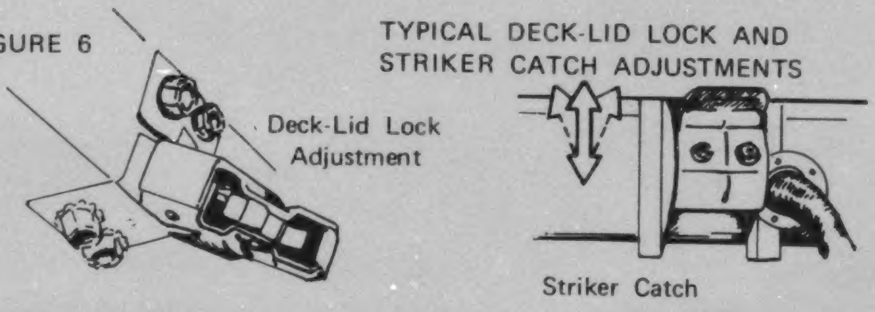
RAISING THE FRONT OF THE DECK LID

LOWERING THE FRONT OF THE DECK LID

3. Setting latch to obtain proper closing adjustment (Figure 6)

FIGURE 6

TYPICAL DECK-LID LOCK AND STRIKER CATCH ADJUSTMENTS


Deck-Lid Lock Adjustment
Striker Catch

ROUGHOUT
UNIT II

JOB SHEET #7--ALIGN A TAILLIGHT ASSEMBLY

I. Tools and equipment

  A. Screwdriver

  B. Phillips screwdriver No. 1, No. 2

  C. Ratchet 1/4" drive

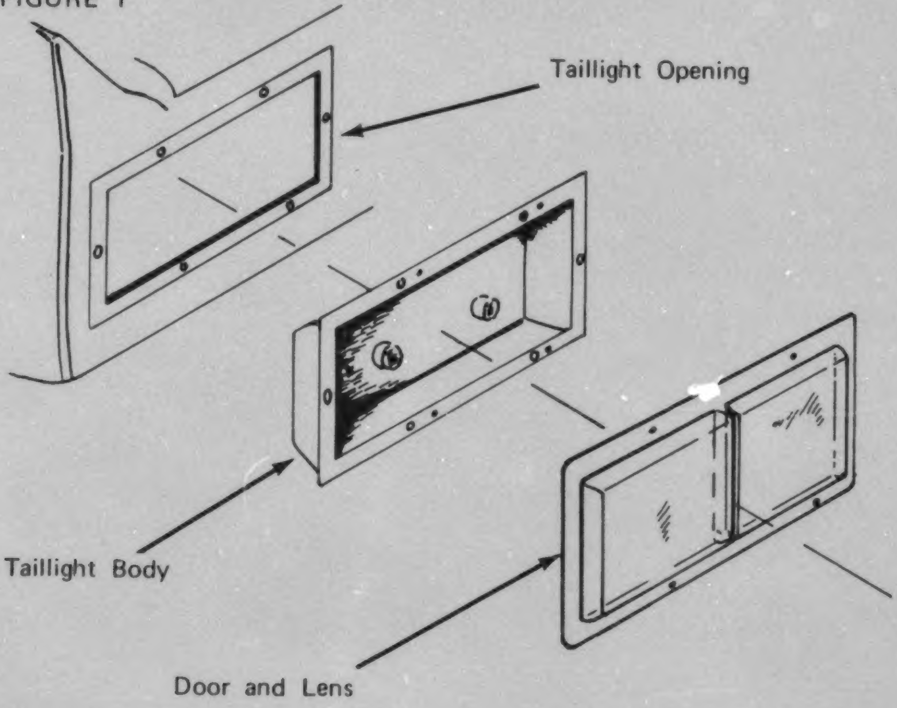
  D. Socket 11/32" thru 9/16" by 1/4" drive

  E. Extention 1/4" drive by 3", 6"

II. Procedure

  A. Check clearance as illustrated (Figure 1)

FIGURE 1


Taillight Opening
Taillight Body
Door and Lens

    1. Taillight body to opening

    2. Taillight door to panel

JOB SHEET #7

B. Fit taillight assembly

1. Shape opening to fit taillight body
    - a. Use the hammer off the dolly method to move metal in or out
    - b. Use the hammer on the dolly to smooth metal

      (IMPORTANT: Do not strike metal too hard or work harding and stretching could occur.)
2. Fit taillight door to body
    - a. Raise or lower metal to obtain correct fit of door to body by using a pick hammer and the hammering off the dolly procedure
    - b. Smooth metal by hammering on the dolly

      (NOTE: Use proper dolly to fit the contour of body panel.)

ROUGHOUT
UNIT II

JOB SHEET #8--ALIGN MOLDINGS AND TRIM

I. Tools and equipment

   A. Screwdriver

   B. Phillips screwdriver No. 1, No. 2

   C. Ratchet 1/4" drive

   D. Socket 1/4" thru 9/16" by 1/4" drive

   E. Extension 1/4" drive by 3", 6"

   F. Combination wrench 5/16" thru 9/16"

   G. Clip tools

   H. Special 1/4" drive nut sockets

   I. Drill--1/4"

   J. Drill bit set

II. Procedure

   A. Check how molding or trim fits panel

   (IMPORTANT: Exercise care when removing snap on trim.)

   B. Rough out panel to fit molding or trim by the hammer off the dolly method

   C. Shape molding or trim to fit panel

      1. Where new moldings and trim are used to fit a new panel

      2. When moldings and trim are damaged but not replaced with new moldings and trim

ROUGHOUT
UNIT II

JOB SHEET #9--ROUGHOUT A SINGLE CROWNED PANEL AND/OR A COMBINATION CROWNED PANEL

I. Tools and equipment
   A. Roughing hammer
   B. Finishing hammer
   C. Pick hammer
   D. Dolly blocks
      1. Bumping
      2. Heel
      3. Comma
      4. General purpose
   E. Spoon
      1. Short curved
      2. Double end
   F. Pry tools
   G. Hydraulic jack set four or ten tons
   H. Oxyacetylene torch

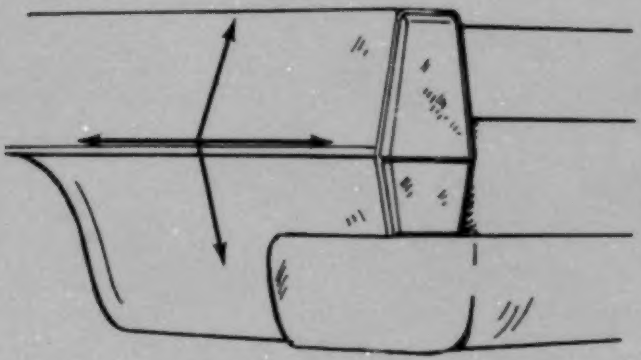
JOB SHEET #9

II. Procedure

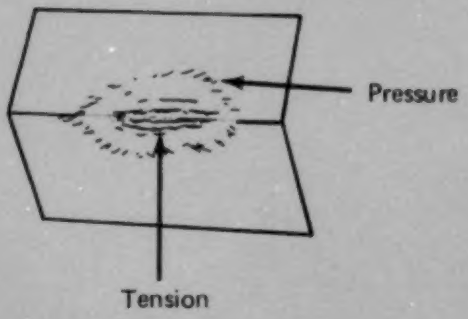
A. Analyze the extent of damage (Figure 1)

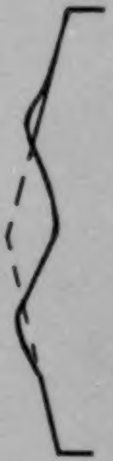
FIGURE 1

Single Crowned Surface



Damaged Single Crowned Surface





Cut Away View of Damage Area

1. Establish the point of impact
2. Locate the direction of damage
3. Locate direct damage
4. Locate indirect damage
    a. Check adjacent panels
    b. Check frame

JOB SHEET #9

   c. Check internal body panels and supports

5. Determine panels and parts to be straightened or replaced

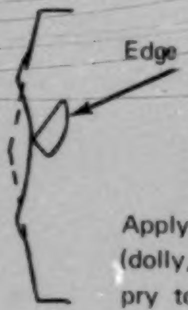
   (NOTE: Estimate will furnish this information.)

6. Establish the starting point

B. Repair damage

1. Apply pressure to damaged crown (Figure 2)

FIGURE 2



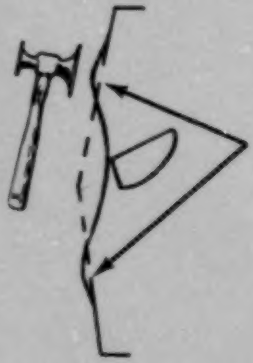
Edge of Heel Dolly

Apply Pressure to the Channel
(dolly, double end body spoon,
pry tools, hydraulic jack)

(NOTE: Pressure may be applied by several methods.)

2. Release strain in pressure areas (Figure 3)

FIGURE 3



Remove Strain from
Pressure Area

   a. Use a finishing hammer if light force is needed

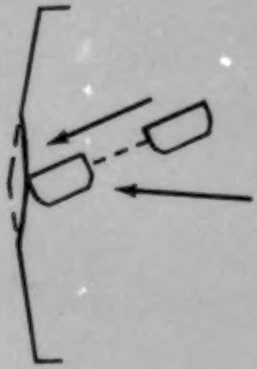
   b. Use a light body spoon if heavy force is needed

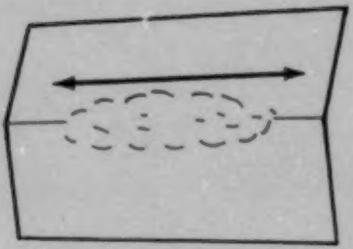
   (IMPORTANT: Do not force metal to move if it resists. Try a different technique and review the analysis of damage. Force will stretch and work harden the metal.)

JOB SHEET #9

c. Bump out crown to correct contour with edge of dolly (Figure 4)

FIGURE 4


With Pressure Removed
Drive Up Channel


Work Panel Back and Forth
Along Entire Panel Length

(NOTE: Pry tools may be used to apply pressure while working strain to raise crown in isolated areas.)

Example: Behind wheel housing, along rear quarter panel, behind door guard rails, or other isolated areas

ROUGHOUT
UNIT II

JOB SHEET #10–ROUGHOUT A LOW CROWNED PANEL

I. Tools and equipment

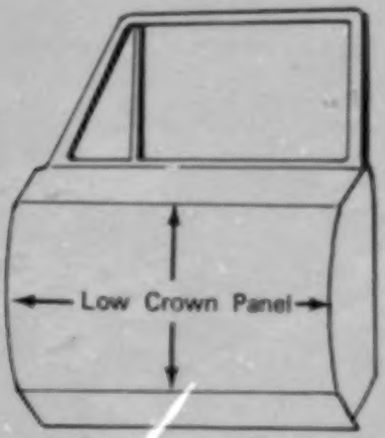
- A. Roughing hammer
- B. Finishing hammer
- C. Pick hammer
- D. Dolly blocks
  - 1. Bumping
  - 2. Heel
  - 3. Comma
  - 4. General purpose
- E. Spoon
  - 1. Short curved
  - 2. Double end
- F. Pry tools
- G. Hydraulic jack set 4 or 10 tons
- H. Oxyacetylene torch

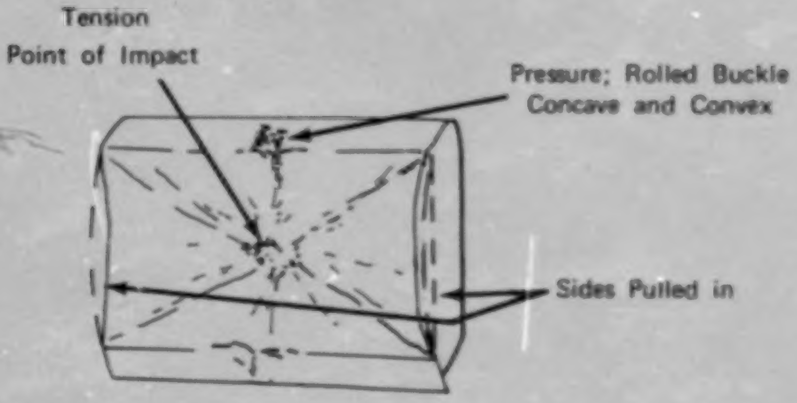
JOB SHEET #10

II. Procedure

A. Analyze the extent of damage (Figure 1)

FIGURE 1


Low Crown Panel


Tension
Point of Impact
Pressure; Rolled Buckle
Concave and Convex
Sides Pulled in

Damaged Low Crown Surface

1. Establish the point of impact
2. Locate the direction of damage
3. Locate direct damage
4. Locate indirect damage
    a. Check adjacent panels

JOB SHEET #10

- b. Check frame
- c. Check internal body panels and supports

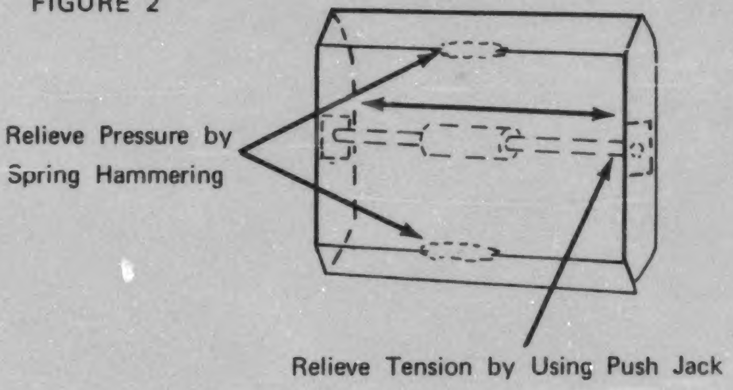
5. Determine panels and parts to be straightened or replaced

   (NOTE: Estimate will furnish this information.)

6. Establish the starting point

B. Repair damage (Figure 2)

FIGURE 2


Relieve Pressure by Spring Hammering
Relieve Tension by Using Push Jack

1. Push supporting sides of panel back to their original position (Figure 2)
2. Apply pressure behind the panel to pop out damaged area
   - a. Tools
     - 1) Hydraulic spread jack
     - 2) Double end spoon
   - b. Hand

     (NOTE: Do not let pressure off body jack during this operation.)
3. Relieve pressure by spring hammering

JOB SHEET #10

4. Smooth concave and convex buckles
    a. Hammering off dolly to raise and lower metal
    b. Hammering on dolly to smooth metal

    (IMPORTANT: Do not stretch or work harden panel.)

5. Shape edges of panel to correct damage from body jack clamps

ROUGHOUT
UNIT II

JOB SHEET #11–ROUGHOUT A DOUBLE HIGH CROWNED SURFACE

I. Tools and equipment

   A. Roughing hammer

   B. Finishing hammer

   C. Pick hammer

   D. Dolly blocks

      1. Bumping

      2. Heel

      3. Comma

      4. General purpose

   E. Spoon–Short curved

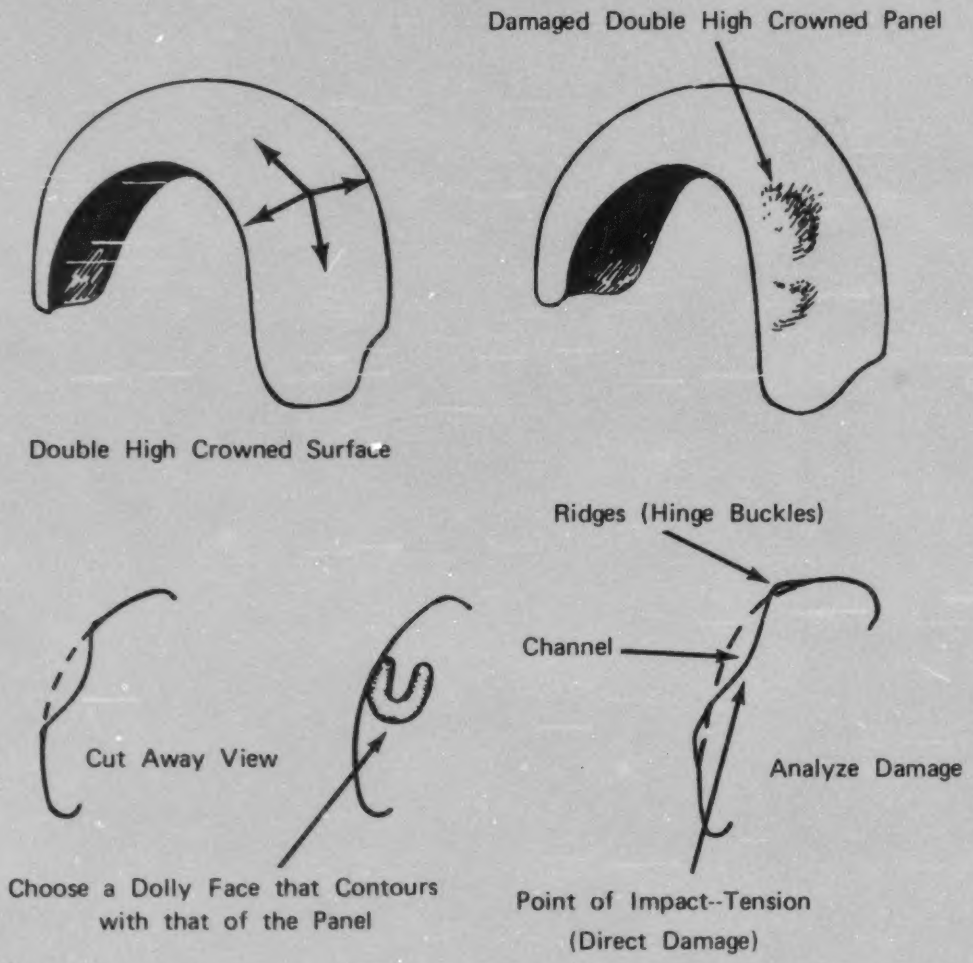
   F. Oxyacetylene torch

JOB SHEET #11

II. Procedure

A. Analyze the extent of damage (Figure 1)

FIGURE 1


Damaged Double High Crowned Panel
Double High Crowned Surface
Ridges (Hinge Buckles)
Channel
Cut Away View
Analyze Damage
Choose a Dolly Face that Contours with that of the Panel
Point of Impact--Tension (Direct Damage)

1. Establish the point of impact
2. Locate the direction of damage
3. Locate direct damage

JOB SHEET #11

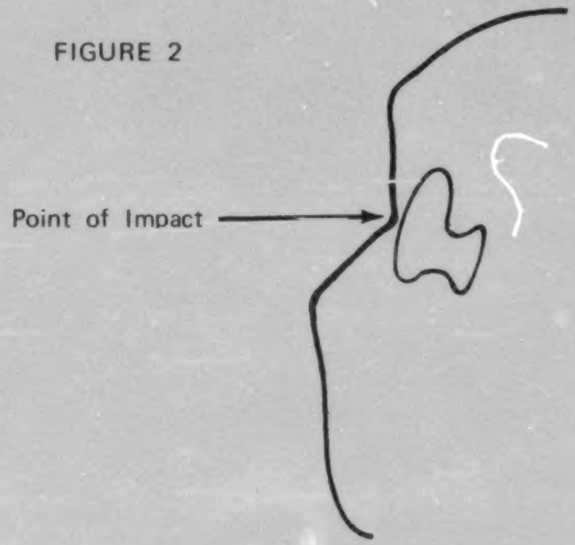
4. Locate indirect damage
    a. Check adjacent panels
    b. Check frame
    c. Check internal body panels and supports
5. Determine panels and parts to be straightened or replaced

    (NOTE: Estimate will furnish this information.)
6. Establish the starting point

B. Repair damage

1. Bump damaged area out (Figure 2)

FIGURE 2



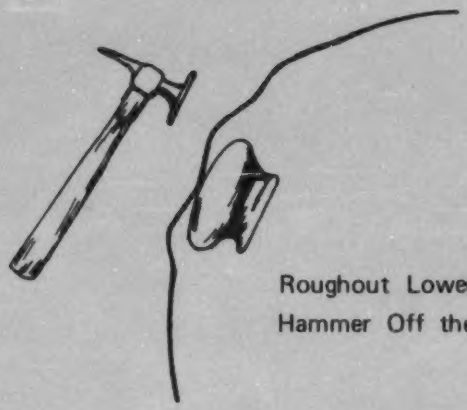
a. Using heavy bumping dolly--Face of dolly should match as close as possible the contour of body panel

b. Use bumping hammer

JOB SHEET #11

2. Lower hinge buckles (Figure 3)

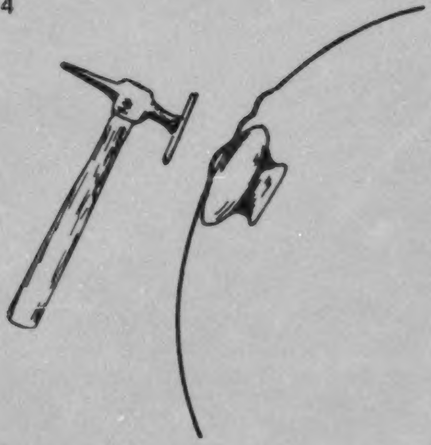
FIGURE 3



Roughout Lower Ridges by Hammer Off the Dolly Method

3. Smooth metal surface (Figure 4)

FIGURE 4



Smooth Metal by Hammer On the Dolly Method

ROUGHOUT
UNIT II

JOB SHEET #12--ROUGHOUT A REVERSED CROWN PANEL

I. Tools and equipment

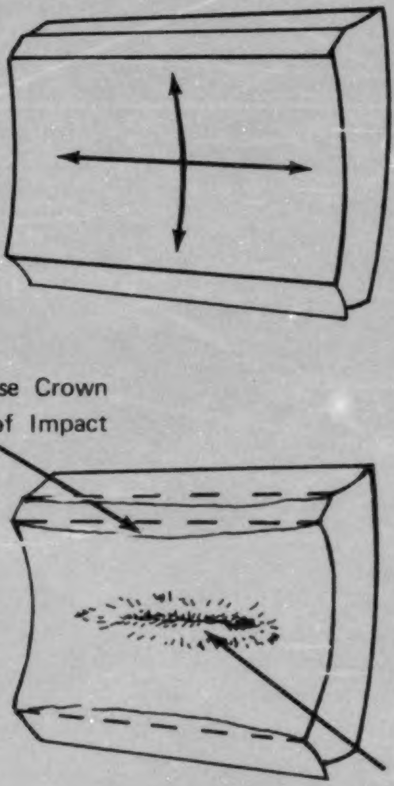
- A. Finishing hammer
- B. Pick hammer
- C. Dolly blocks
  - 1. Bumping
  - 2. Heel
  - 3. Comma
  - 4. General purpose
- D. Spoon--Double end
- E. Pry bars
- F. Oxyacetylene torch

JOB SHEET #12

II. Procedure

A. Analyze the extent of damage (Figure 1)

FIGURE 1



Reversed Crown Panel

Metal On Sides of Reverse Crown is Pulled Toward Point of Impact

Concave Buckle Forward On Impact

Damage: Reverse Curve

1. Establish the point of impact
2. Locate the direction of damage
3. Locate direct damage

JOB SHEET #12

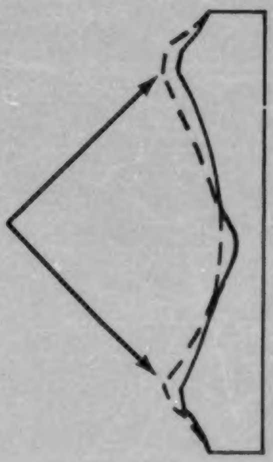
4. Locate indirect damage
    a. Check adjacent panels
    b. Check frame
    c. Check internal body panels and supports
5. Determine panels and parts to be straightened or replaced

    (NOTE: Estimate will furnish this information.)
6. Establish the starting point

B. Repair damage

1. Raise sharp crease by best method (Figure 2)

FIGURE 2



Metal On Side of Damage Should Return to Normal Dimension

    a. Use finish hammer
    b. Use dolly
    c. Use pry tools

    (NOTE: Since this type of panel is usually hard to gain access to, use the tool that will best accomplish the job.)
2. Smooth panel surface
    a. Hammer off the dolly to raise low spots and lower high spots
    b. Hammer on the dolly to smooth metal

        (NOTE: A long spoon may be used in place of the dolly.)

ROUGHOUT
UNIT II

JOB SHEET #13--ROUGHOUT A FLANGE OR BEAD

I. Tools and equipment

   A. Finish hammer

   B. Bead or flange dolly block

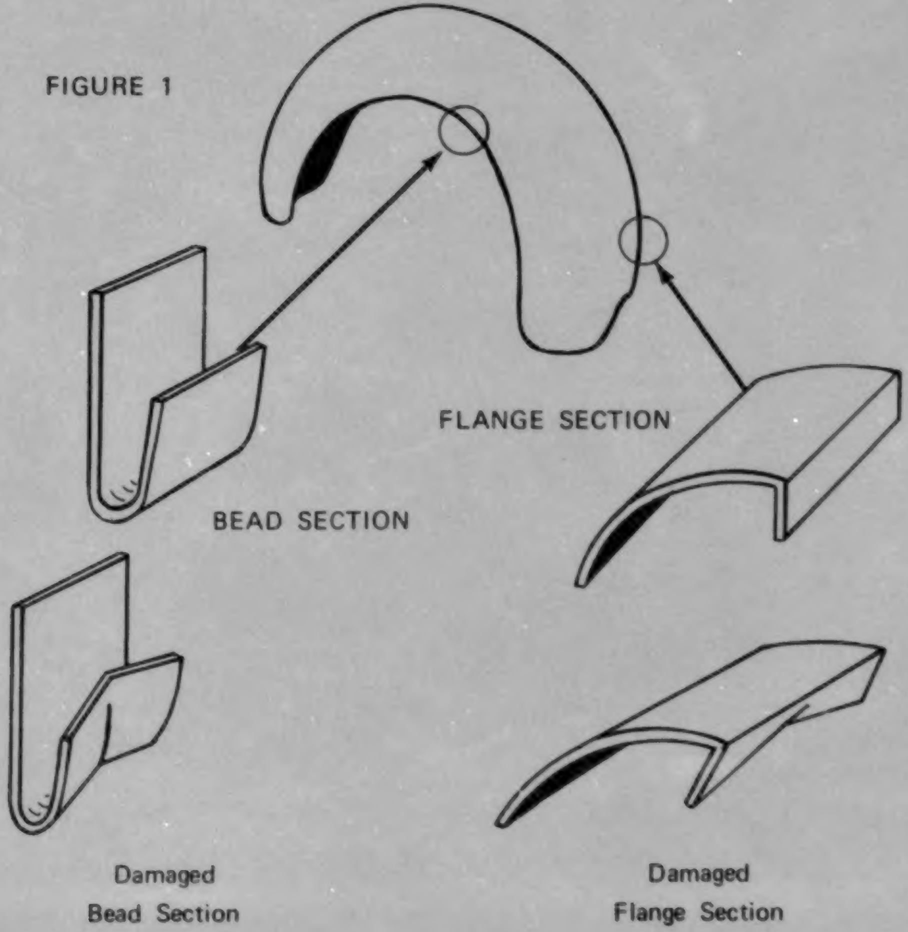
   C. Channel lock pliers

   D. Oxyacetylene torch

II. Procedure

   A. Analyze the extent of damage (Figure 1)

FIGURE 1


FLANGE SECTION
BEAD SECTION
Damaged
Bead Section
Damaged
Flange Section

JOB SHEET #13

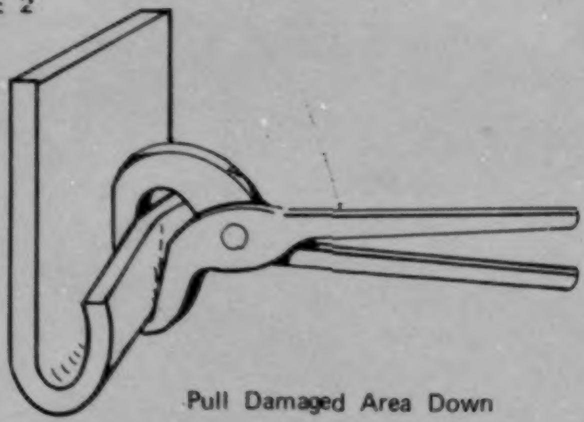
1. Establish the point of impact
2. Locate the direction of damage
3. Locate direct damage
4. Locate indirect damage
    a. Check adjacent panels
    b. Check frame
    c. Check internal body panels and supports
5. Determine panels and parts to be straightened

   (NOTE: Estimate will furnish this information.)
6. Establish the starting point

B. Repair damage

1. Pull damaged area of flange or bead down to gain access to interior (Figure 2)

FIGURE 2



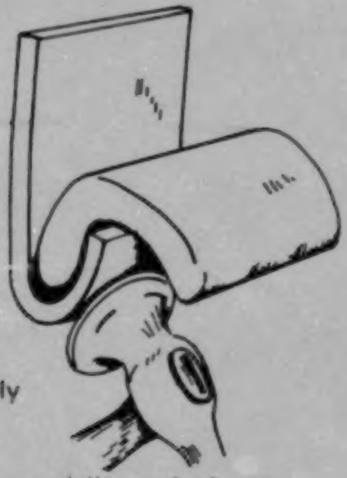
Pull Damaged Area Down

2. Place bead or flange dolly block against damaged area

JOB SHEET #13

3. Form metal around the dolly (Figure 3)

FIGURE 3



Form Metal Around the Dolly

   a. Hammer on dolly method

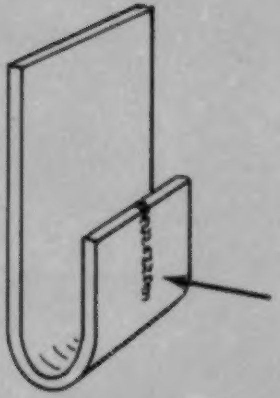
   b. Dolly must conform to original bead or flange surface

   c. Heat damaged area during procedure to shrink metal

   (NOTE: Hammering on the dolly is a shaping operation. Do not work harden or stretch the metal.)

4. Weld any breaks that might exist in bead or flange (Figure 4)

FIGURE 4



Weld Break in Metal

ROUGHOUT
UNIT II

TEST

1. Match the following terms with the correct definitions.

_____a. Body panels are aligned and dents are reshaped to their proper dimensions

_____b. The ability of auto body sheet metal to stretch and return to its original position

_____c. The point that metal can be stretched and still recover

_____d. Ductility or having the ability to yield to bending or forming

_____e. Change of grandular structure of metal by bending or forming

_____f. Damage which is the direct result of the collision force at the point of impact and the immediately surrounding area

_____g. When the impact force travels through the direct damage area surrounding the point of impact, then causes damage to other areas of the same panel or connecting panels and areas

_____h. The direction that the metal has shifted from the impact point

_____i. Swelling and thinning of metal due to improper hammer and dolly technique

_____j. Opposite of stretch; compressing the metal

_____k. A pushing force or point of direct damage to a body panel; metal that is pushed up

1. Hinge buckle
2. Upset
3. Direction of impact
4. Roughout
5. Roll buckle
6. Plastic deformation
7. Stretch
8. Pressure
9. Elasticity
10. Direct damage
11. Tension
12. Elastic limit
13. Work hardening
14. Indirect damage

_____l. A pulling force; metal that is pushed down

_____m. Bending or piviot point from which two areas of relatively undamaged metal have moved or shifted

_____n. When metal on each side of the pivot point is pulled together and forced to roll over on its side

2. State the purpose for aligning detachable parts.

3. List three steps the repairman must consider in analyzing the job

a.

b.

c.

4. List three clues that determine direction of damage.

a.

b.

c.

5. Name the effects of bending body sheet metal.

a.

b.

c.

6. Name the effects of bending hollow (box section) metal.

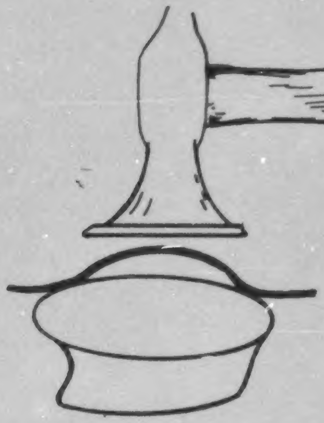
a.

b.

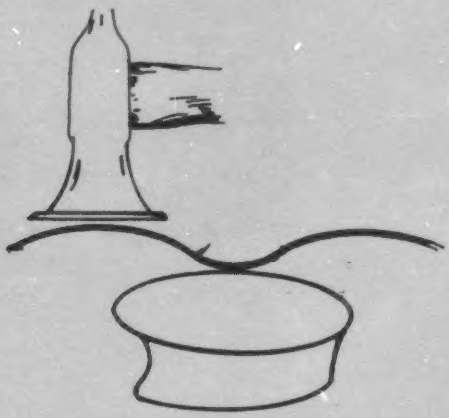
c.

7. Describe the use of the dolly in roughout.

8. Identify the hammering on and off the dolly techniques.



a.



b.

a.

b.

9. Describe the picking technique.

10. Demonstrate the ability to:

   a. Align a hood.
   b. Align a fender.
   c. Align a headlight assembly.
   d. Align a bumper.

e. Align a door.

f. Align a deck lid.

g. Align a taillight assembly.

h. Align moldings and trim.

i. Roughout a single crowned panel and/or combination crowned panel.

j. Roughout a low crowned panel.

k. Roughout a double high crowned panel.

l. Roughout a reversed crown panel.

m. Roughout a flange or bend.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

ROUGHOUT
UNIT II

ANSWERS TO TEST

1. a. 4
   b. 9
   c. 12
   d. 6
   e. 13
   f. 10
   g. 14
   h. 3
   i. 7
   j. 2
   k. 8
   l. 11
   m. 1
   n. 5
2. To help set dimensions and specifications for repair of body panels and installation of outer finish panels
3. a. Extent of damage
   b. Method of repair
   c. Order of repair
4. a. Rolled buckles
   b. Direct damage marks
   c. Pressure forces
5. a. Outer surface of bend becomes stretched
   b. Center remains the same
   c. Inner surface is upset (compressed and thicker)

6. a. *Upper or top is pulled* downward (little or no stretching occurs)
   b. Lower or bottom collapses
   c. Sides collapse along with bottom
7. Used as an impact tool such as a hitting force to raise low areas and unroll buckles
8. a. On dolly technique
   b. Off dolly technique
9. Raises up the metal by use of a pointed object (pick hammer, long pick tool, scratch awl, edge of the file or a dolly); picking in roughout raises metal without upsetting the metal
10. Performance skills will be evaluated according to the criteria listed on the progress chart.

METAL FINISHING
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define the terms associated with metal finishing and determine the methods of grinding and filing necessary to accomplish the job. He should also be able to finish metal to the desired specification necessary for refinishing. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with metal finishing to a list of definitions.
2. Name two types of grinders used in body sheet metal repair.
3. List three uses of a body grinder.
4. State the angle of contact of the disc off the metal.
5. Describe the buffing method when using the body grinder.
6. Describe crosscutting when using the body grinder.
7. Describe metal polishing when using the body grinder.
8. Match the filing hatch patterns to the filing methods.
9. Describe the method of picking up low spots.
10. Describe how to locate low and high spots.
11. Demonstrate the ability to:
    a. Remove paint from a damaged area on a body panel by buffing.
    b. Grind, pick, and file a flat panel.
    c. Grind, pick, and file a high crown panel.
    d. Grind, pick, and file a reverse crown area.
    e. Grind, pick, and file a concave groove.
    f. Finish buff.

METAL FINISHING
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Buffing

    2. TM 2--Crosscutting (Discing)

    3. TM 3--Crosscut Pattern

    4. TM 4--Hexagon and Square Cut Discs

5. TM 5--Cross Filing
6. TM 6--X Filing
7. TM 7--Body Grinders
8. TM 8--Disc Angle
9. TM 9--Buffing Method
10. TM 10--Crosscut Method
11. TM 11--Line Filing
12. TM 12--Locating High and Low Spots

D. Job sheets

1. Job Sheet #1--Remove Paint
2. Job Sheet #2--Grind, Pick, and File a Flat Panel
3. Job Sheet #3--Grind, Pick, and File a High Crown Panel
4. Job Sheet #4--Grind, Pick, and File a Reverse Crown Panel
5. Job Sheet #5--Grind, Pick, and File a Groove
6. Job Sheet #6--Finish Buff

E. Test

F. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto Canada: McGraw-Hill Company of Canada Limited, 1969.

B. McPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Book Company Inc., 1971.

C. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

D. Toboldt, Bill. *Autobody Repairing and Repainting.* Third Edition. South Holland, Illinois: Goodheart-Willcox Company, Inc., 1972.

METAL FINISHING
UNIT III

INFORMATION SHEET

I. Terms and definitions (Transparencies 1, 2, 3, 4, 5, and 6)

   A. Buffing--Grinding motion where the grinder is moved up and down using the top portion of the grinding disc

   B. Crosscutting--Also known as discing; the grinding motion is from side to side using the top of the disc only

   C. Metal polishing--Finish grinding with a fine disc to obtain a smooth surface after metal finishing is complete

   D. Crosscut--Pattern the abrasive cuts into the metal when grinding

   E. Closed coat disc--Disc used for grinding metal after the paint has been removed with an open coat disc; paint or body filler will plug this disc

   F. Open coat disc--Disc used for grinding paint off the surface and any other coating which might plug up and ruin a closed coat disc

   G. Backing--The paper, cloth, or fibre that the abrasive is bonded to

   H. Hexagon or square cut discs--Discs are cut in this design to clean damaged areas and welds

      (CAUTION: Discs cut in this design have sharp corners which catch easily and the grinder could be flipped from the operator's hands.)

   I. Picking--Using the pick hammer to raise metal during the grinding and filing of metal finishing

   J. Cross filing--Filing in one direction followed by filing a second time across the first at a 45° angle; method of check filing

   K. X filing--Filing in one direction followed by filing a second time across the first at a 90° angle; method of check filing

   L. Line filing--Filing in one direction only

   M. Half round or shell file--File designed in the half round shape to file convex and reverse curves

II. Types of grinders used in body repair (Transparency 7)

   A. Electric sander or grinder--Used in most body shops

   B. Pneumatic sander or grinder--Latest addition to body shops; excellent because of light weight and variable speed control

INFORMATION SHEET

III. Three uses of a body grinder

   A. Buffing--Removal of paint and finishing metal in the finish stage of metal work

   B. Crosscutting or discing--Smoothing the metal prior to filing

   C. Metal polishing--Final buffing of metal finishing

IV. The angle of contact of the grinding disc (Transparency 8) with the metal--From 10° to 20°; at no time should over 1 1/2" to 2" of the disc contact the metal

V. Buffing method (Transparency 9)--The grinder should move up and down panel using the top portion of the disc; each cut of the disc should overlap the first

VI. Crosscutting method (Transparency 10)--The grinder should move from side to side using the right side of the disc; the crosscut of the disc will make an "X" angle to the first during each pass of the grinder

VII. Metal polishing--The finish buffing of metal to remove coarse disc and file scratches preparing the surface for the painter

VIII. Three filing hatch patterns (Transparency 11)

   A. Cross filing--A method used to check the metal surface being filed; after filing in one direction, file across at a 45° angle to be sure the metal is level in all directions

   (NOTE: Some body men call this check filing.)

   B. X filing--Another method used to check the metal surface being filed to be sure its smooth and level in all directions

   (NOTE: This is also known as check filing.)

   C. Line filing--Filing in one direction only and used on high crown surfaces where "X" or cross filing cannot be done

IX. Method of picking up low spots-- Accomplished with a sharp nosed pick hammer

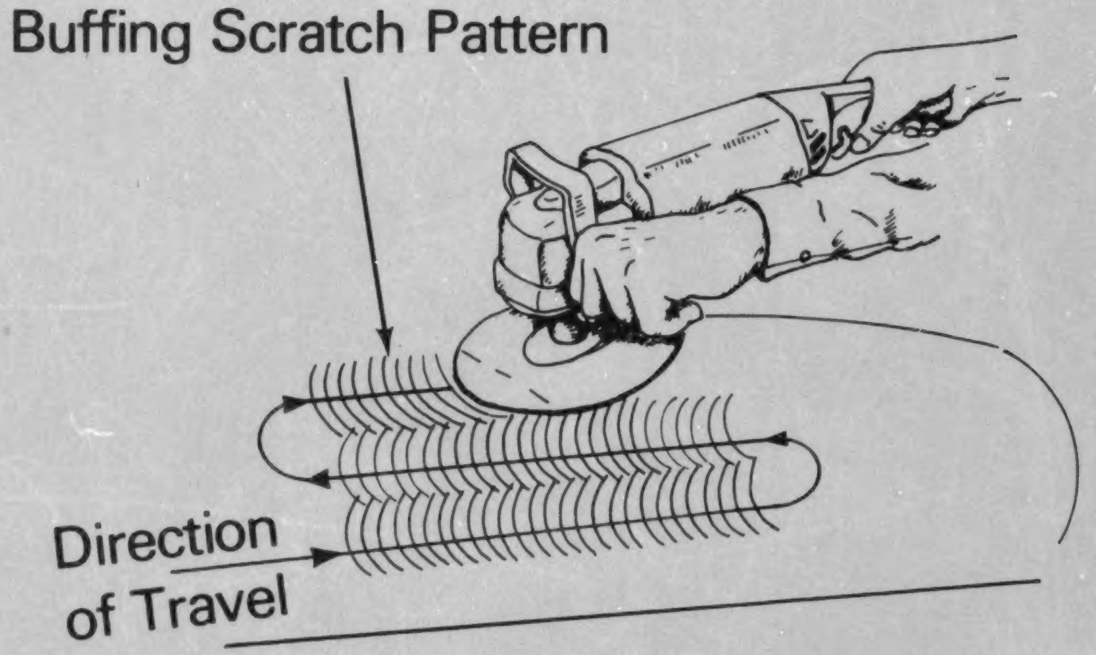
(NOTE: By the time one has reached metal finishing, the metal should be relatively smooth. A very sharp pick hammer should be used because little metal needs to be raised and a blunt nose pick hammer would raise too much causing stretch to occur.)

X. Locating low and high spots (Transparency 12)

   A. Feel the surface with a cotton glove or cloth to detect surface imperfections

   B. File scratch pattern to locate low and high spots

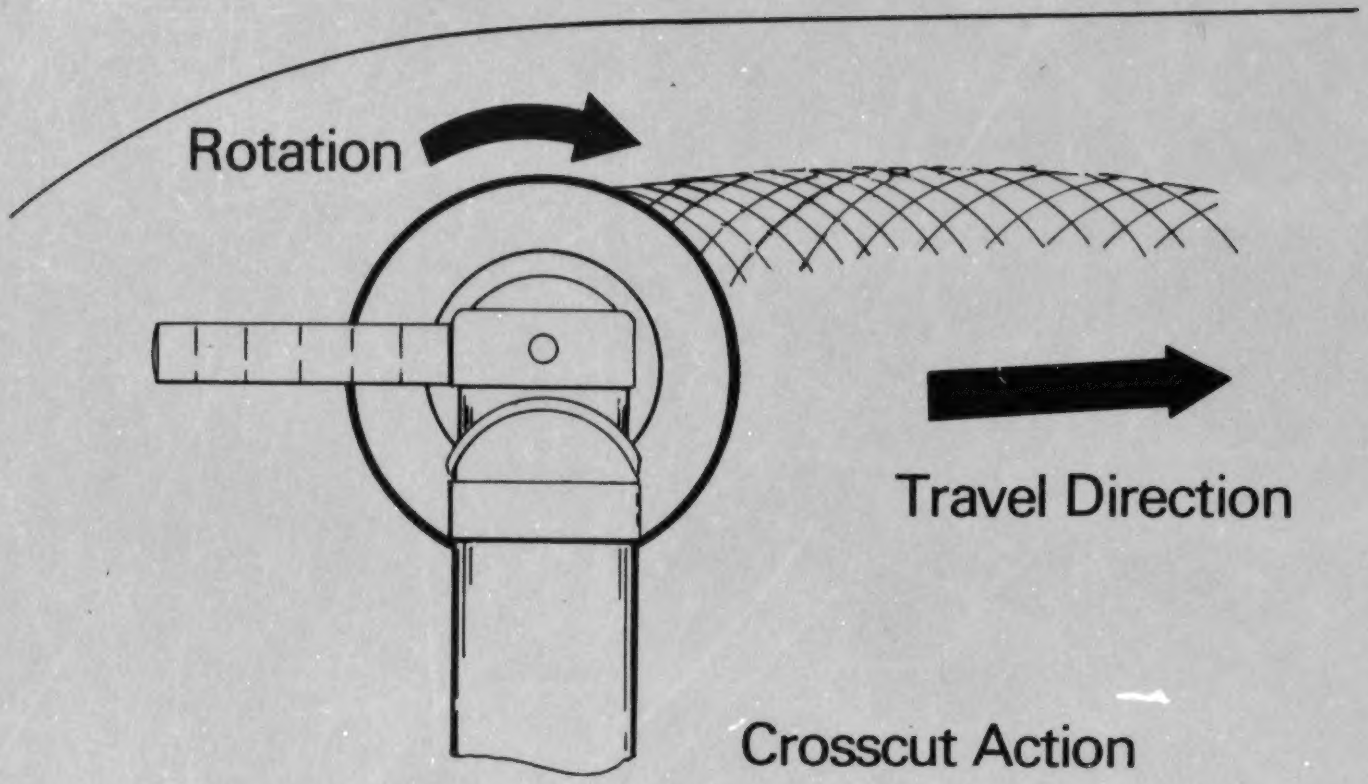
Buffing


Buffing Scratch Pattern
Direction
of Travel

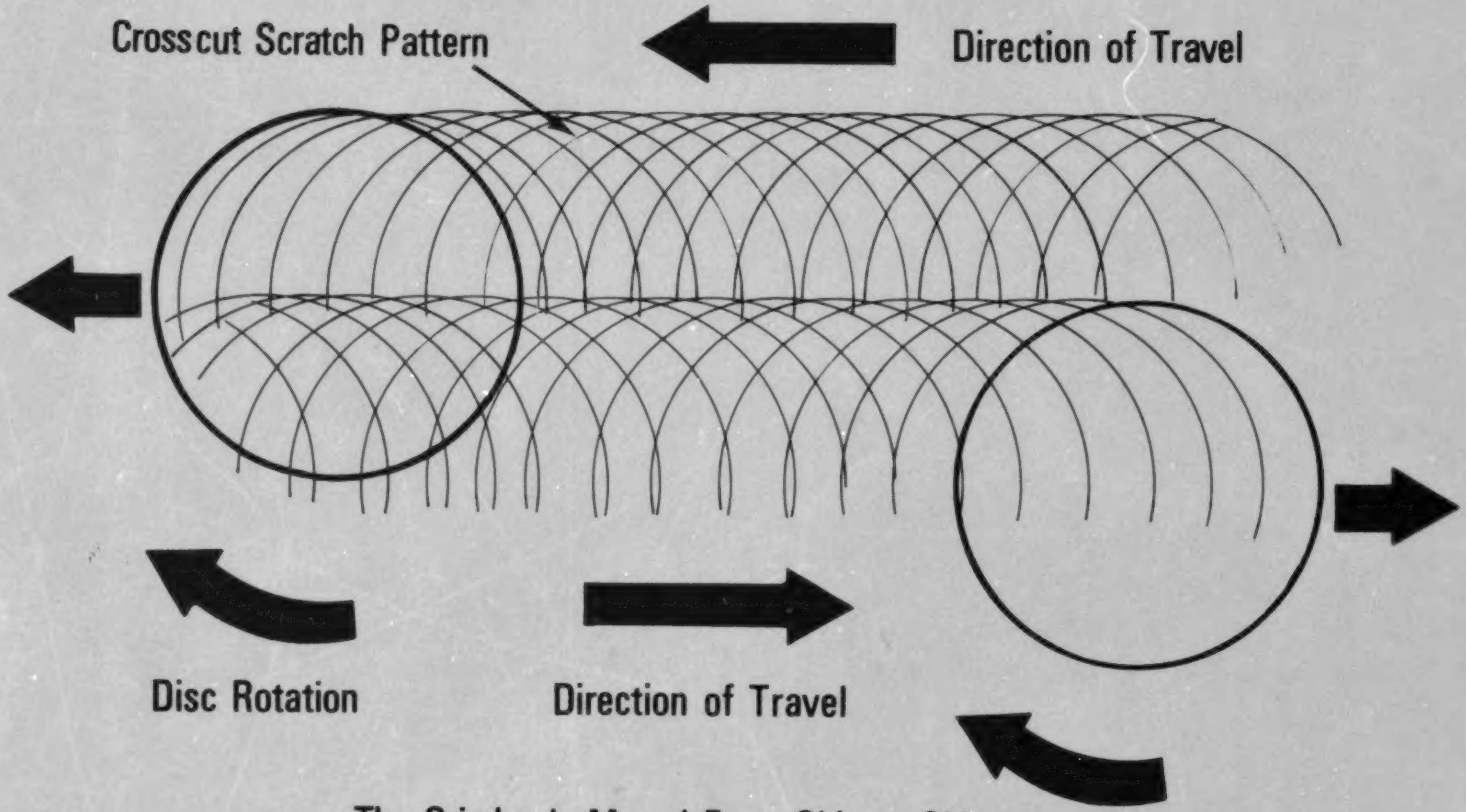
Grinder is Moved Up and Down

Crosscutting

(DISCING)

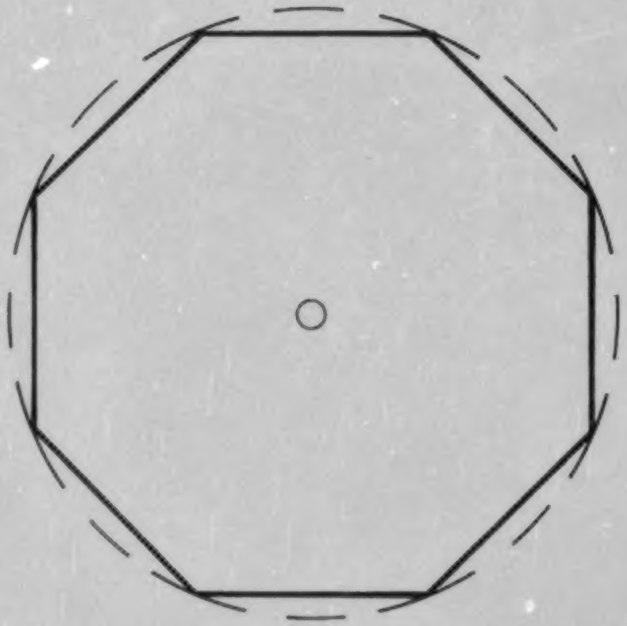

Rotation
Travel Direction
Crosscut Action

Crosscut Pattern

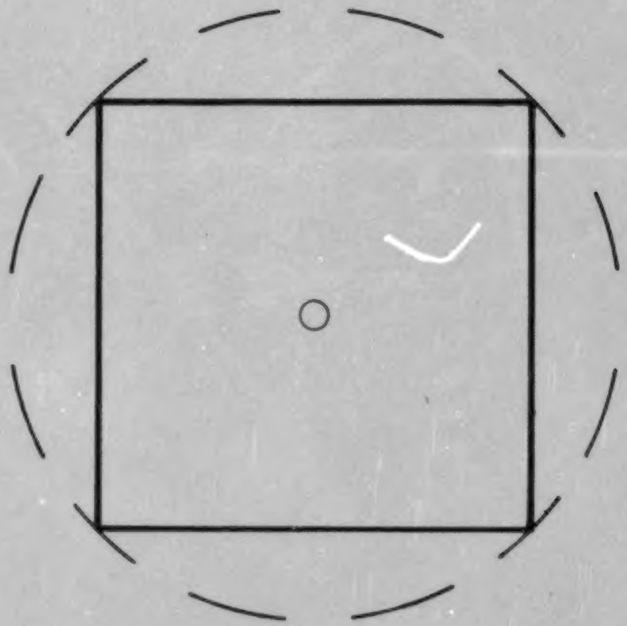

Crosscut Scratch Pattern
Direction of Travel
Disc Rotation
Direction of Travel

The Grinder is Moved From Side to Side

Hexagon and Square Cut Discs



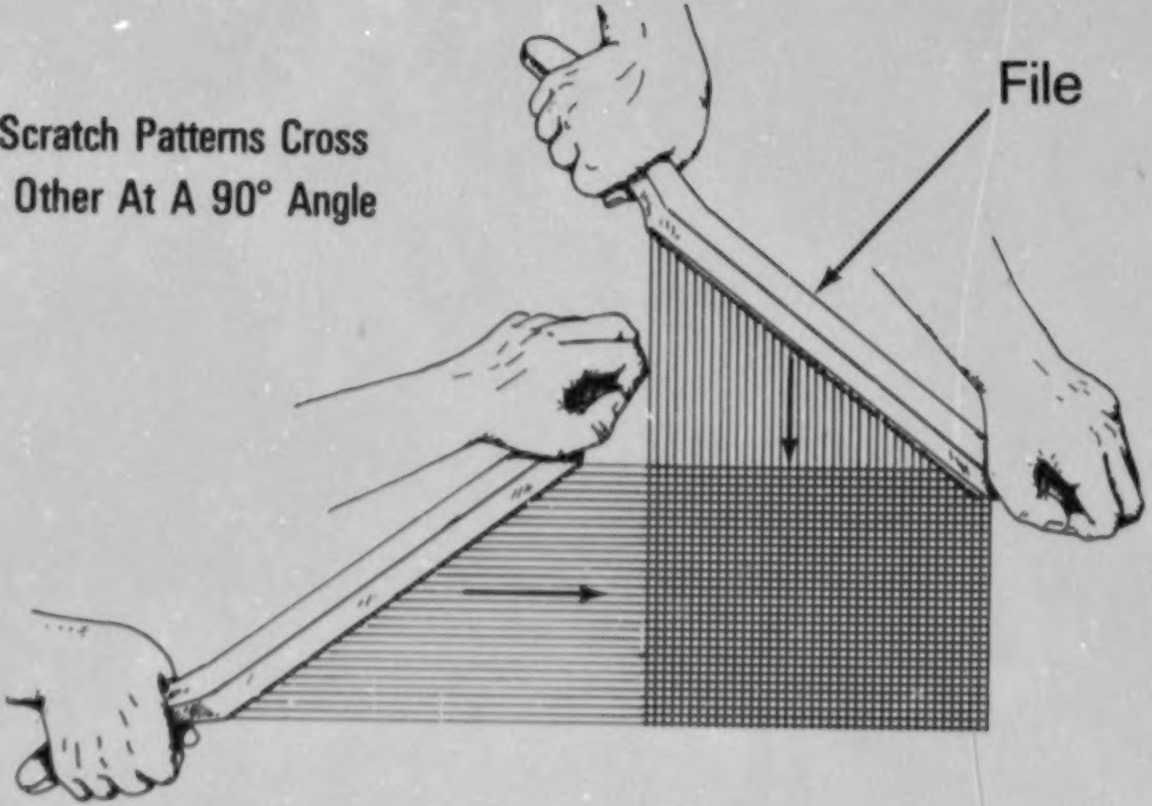
Hexagon



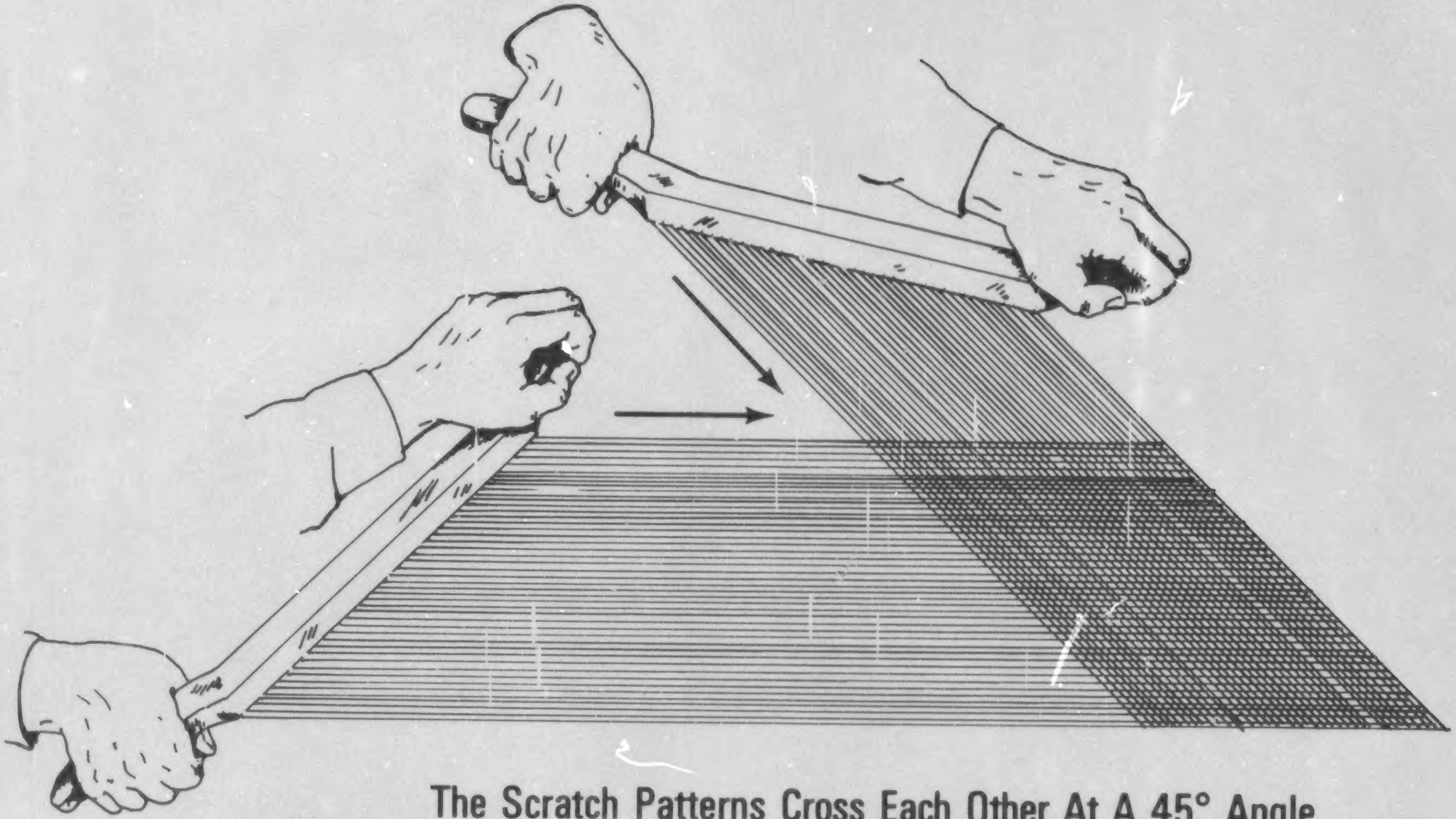
Square

Cross Filing

The Scratch Patterns Cross
Each Other At A 90° Angle

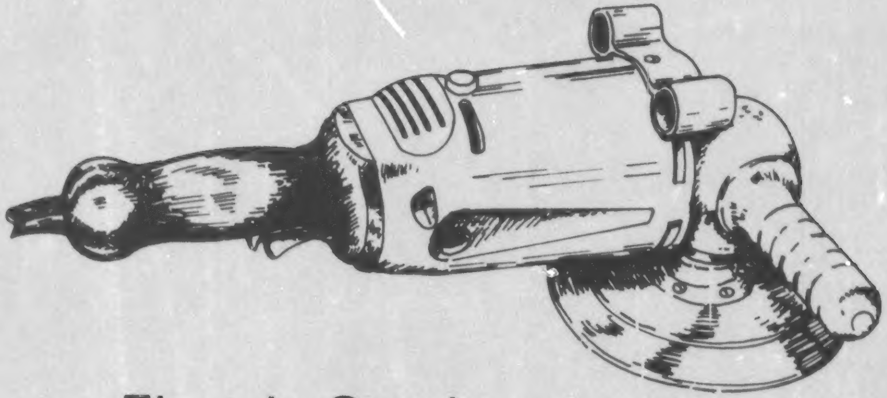


X Filing



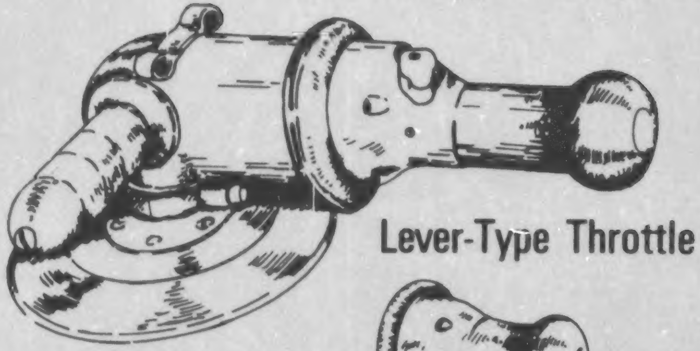
The Scratch Patterns Cross Each Other At A 45° Angle

Body Grinders

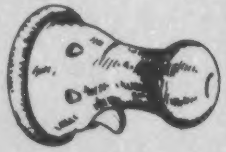


Electric Sander

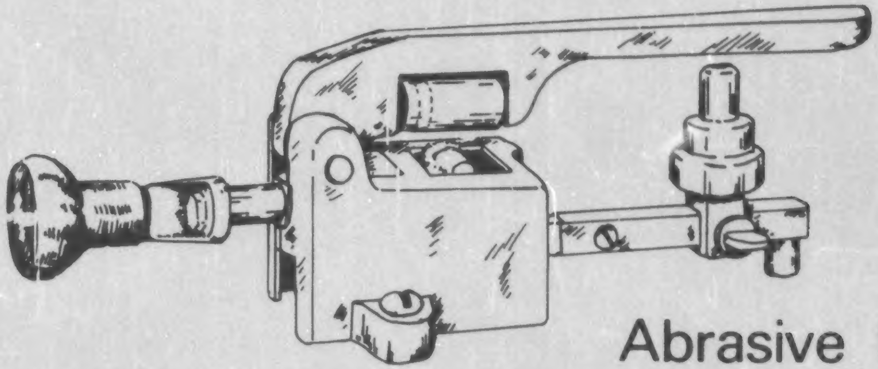
Thumb-Type Throttle



Lever-Type Throttle

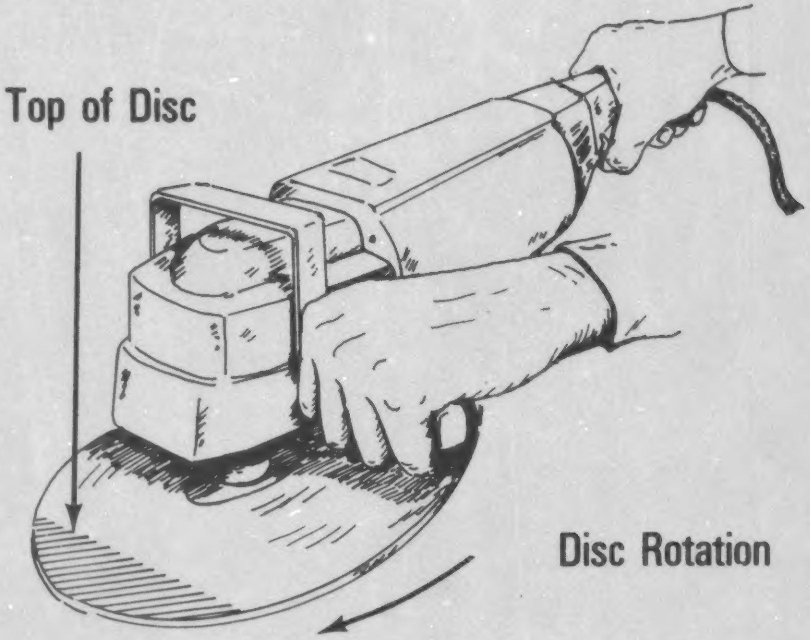


Air Sander

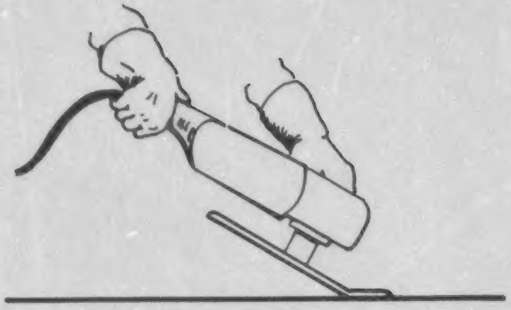


Abrasive Disc Cutter

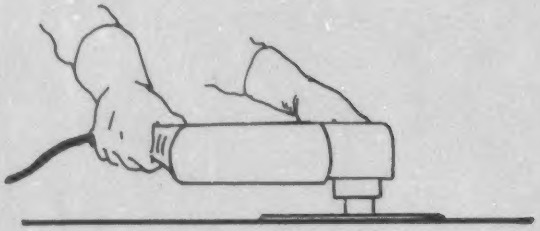
Disc Angle


Top of Disc
Disc Rotation

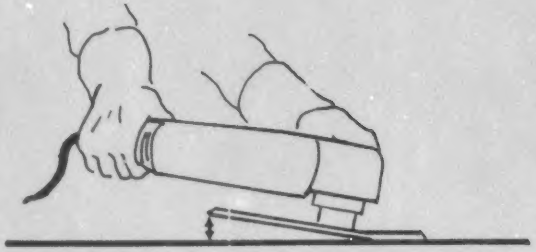
1½ to 2 Inches Should Contact Metal



Too High



Too Flat

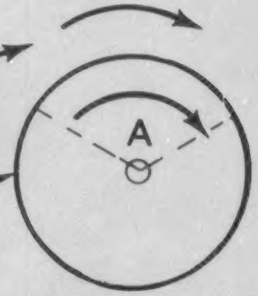


Correct 10°-20° Angle

Buffing Method

Draw a line on the practice panel similar to this one.

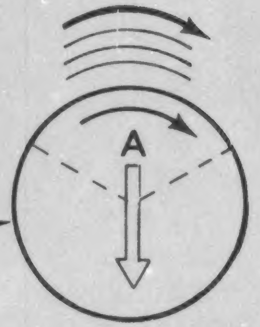
Draw lines on 16-grit open coat disc and mark A.



A=Area of disc contact

Hold disc to panel and move in direction shown.

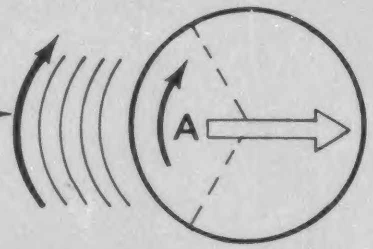
Mark arrows on panel as shown.



Arrow=Direction of travel

Repeat steps holding disc at 90° from previous position.

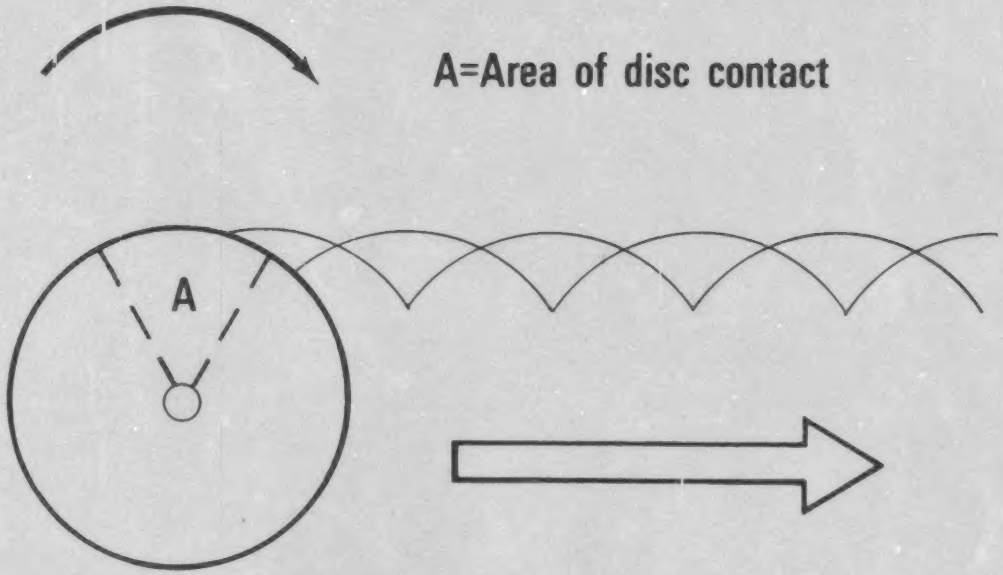
Begin discing practice.



TM 9

139-F

Crosscut Method



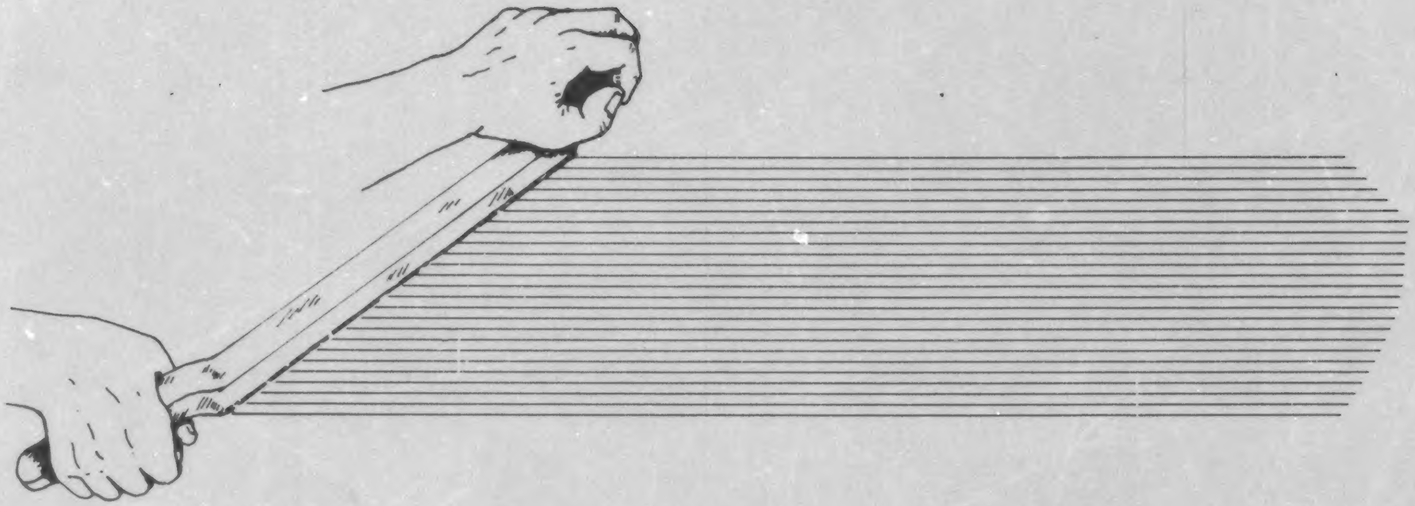
Draw line on panel

A=Area of disc contact

Move disc sideways and
mark panel as shown.

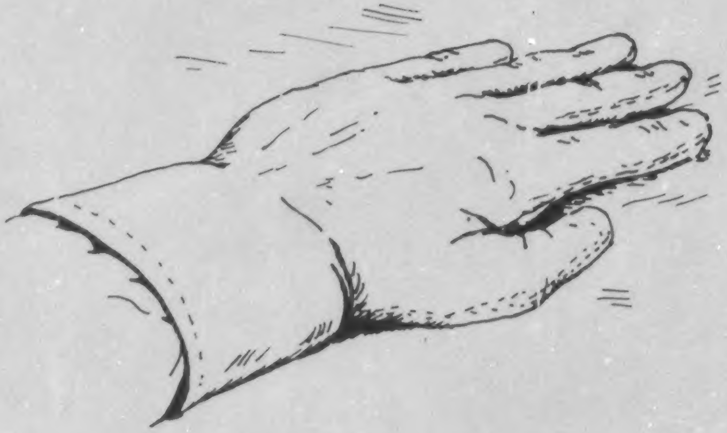
Arrow=Direction of travel

Line Filing

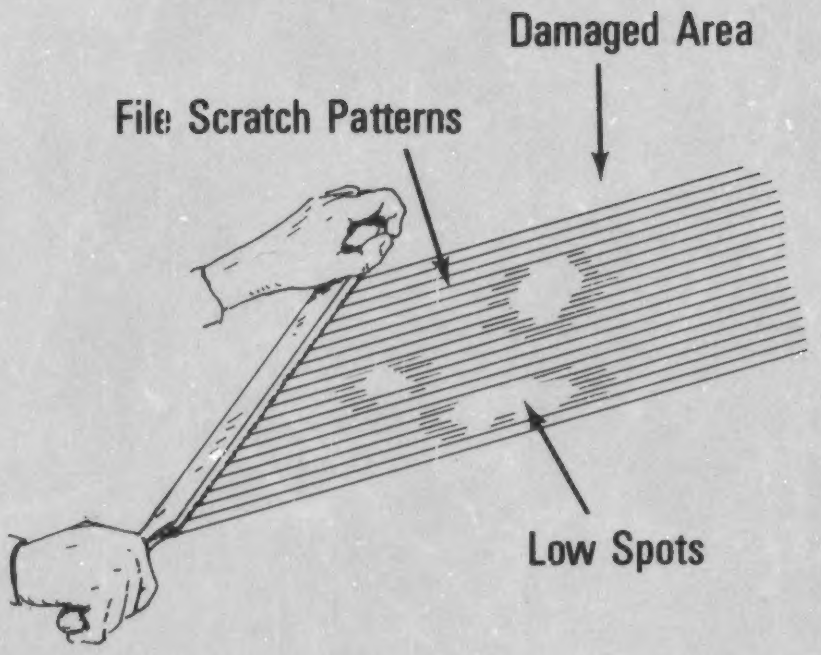


The Scratch Patterns Result From Filing In One Direction Only

Locating High and Low Spots



FEEL THE METAL FOR
SURFACE IMPERFECTIONS


Damaged Area
File Scratch Patterns
Low Spots

FILE SCRATCH PATTERN
SHOWS UP LOW SPOTS

METAL FINISHING
UNIT III

JOB SHEET #1--REMOVE PAINT

I. Tools, equipment, and materials

- A. Portable body grinder
- B. Gloves
- C. Goggles or safety glasses
- D. 16 grit open coat grinding disc
- E. Protective tape

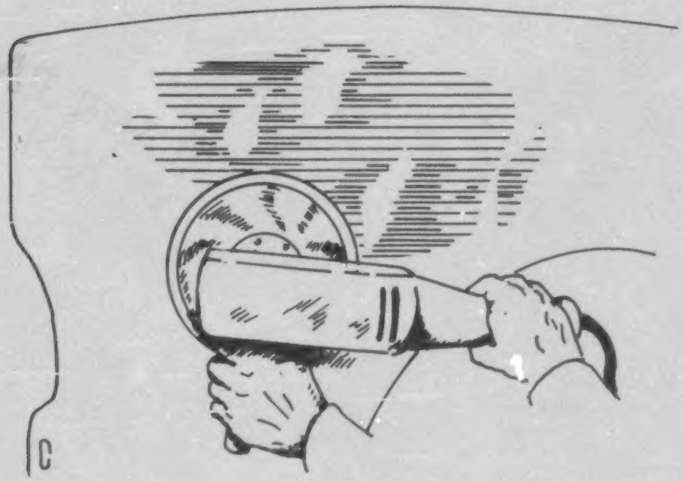
II. Procedure

A. Tape areas, moldings, bumper, and adjacent panels

(NOTE: This helps prevent damage due to accidental creeping of grinder or sander.)

B. Buff the paint off the damaged area (Figure 1)

FIGURE 1



First the disc is used to remove the paint. There is a special cutting action here (called "buffing") as well as a special type of disc.

(NOTE: Always buff from left upper edge moving down with each pass.)

METAL FINISHING
UNIT III

JOB SHEET #2--GRIND, PICK, AND FILE A FLAT PANEL

I. Tools, equipment, and materials

  A. Sharp pick hammer

  B. Body file

  C. Portable grinder

  D. Goggles or safety glasses

  E. Gloves (cotton)

  F. 16 or 24 grit closed coat grinding disc

  G. Protective tape

  H. Chalk

II. Procedure

  A. Tape areas, moldings, bumper, and adjacent panels

  (NOTE: This helps prevent damage due to accidental creeping of grinder, sander, or body file.)

  B. Disc surface

  (NOTE: Buffing (Job Sheet #1) should have already been accomplished.)

  C. Locate low spots

    1. Feel with gloved hand or cotton cloth

    2. Mark with chalk

JOB SHEET #2

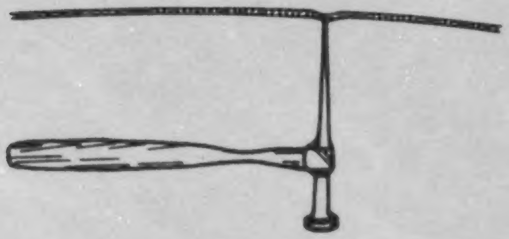
D. Pick up low areas (Figure 1)

1. Locate the area
2. Pick up the area

FIGURE 1

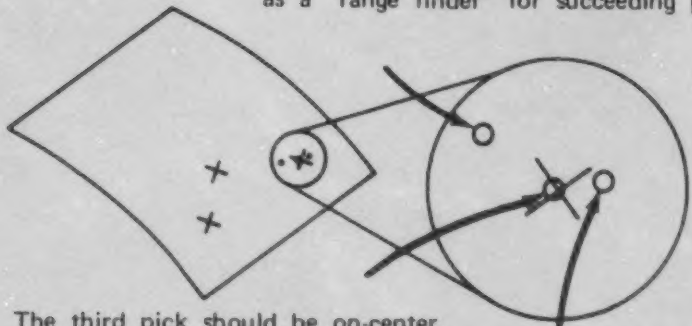
To practice, place three or more cross marks on a practice panel as shown and then try to "pick" them up. These marks need not be dents.

A



The first pick is very light and is used as a "range finder" for succeeding picks.

B



The third pick should be on-center.

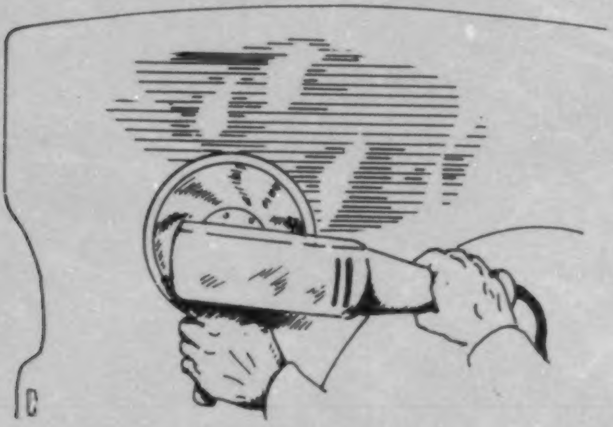
The second pick is harder and if not on-center can be used to guide the next.

JOB SHEET #2

E. Crosscut the surface (Figure 2)

FIGURE 2

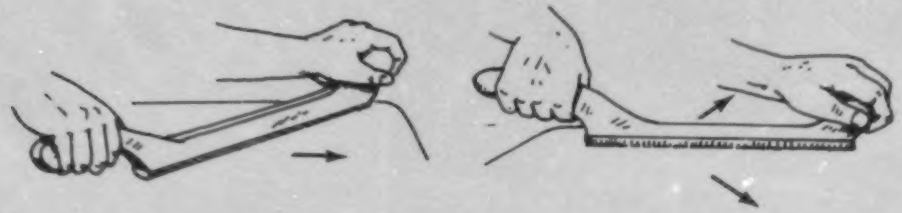
Once the paint is removed, straightening and discing can continue. The fender is in the finishing stage of the repair. Picking and discing are combined here. There is a special discing action (called "crosscut") and disc used at this time.



(NOTE: Picking and discing action should be done until surface feels smooth. Do not try to finish the panel with the grinder, because it will not do precision work.)

F. File the panel (Figure 3)

FIGURE 3



Held At A 30° Angle And Pushed Straight

Or Held Straight And Pushed At A 30° Angle

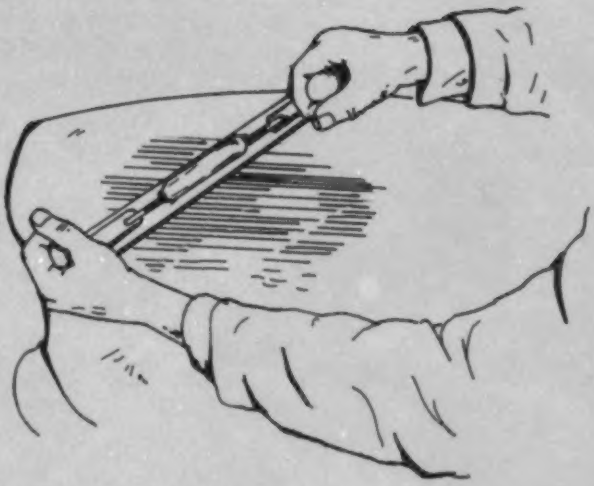
1. Pick up low spots

JOB SHEET #2

2. Check file surface (Figures 4 and 5)

FIGURE 4

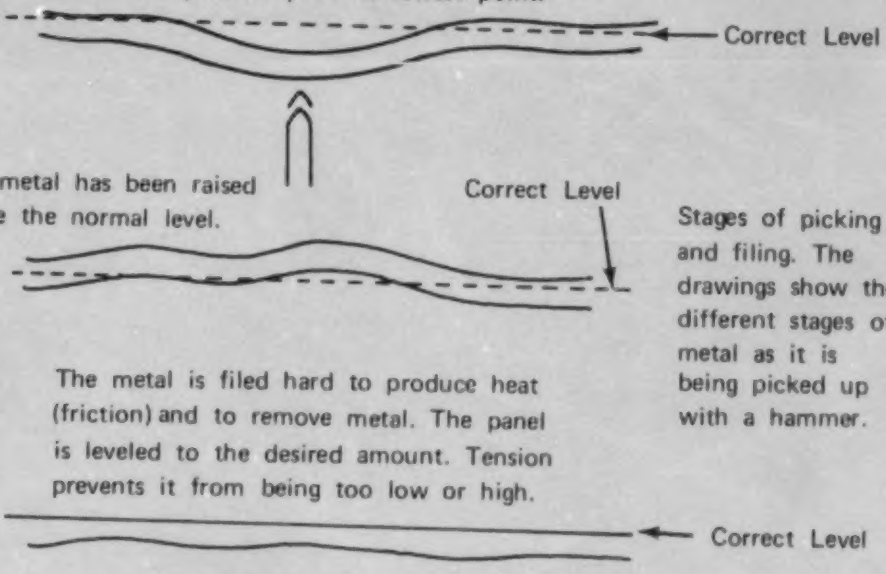
The disc cannot be used beyond this stage for straightening but will later be used for "polishing." The file must now take over the work. Picking and filing continue until the metal is completely straight. Special methods of filing are done at this time.



a. X filing

b. Cross filing

FIGURE 5



The metal is low and irregular. It is picked up at its lowest point.

The metal has been raised above the normal level.

Stages of picking and filing. The drawings show the different stages of metal as it is being picked up with a hammer.

The metal is filed hard to produce heat (friction) and to remove metal. The panel is leveled to the desired amount. Tension prevents it from being too low or high.

(NOTE: The beginning student should concentrate on using the file. Too much use of the pick hammer and too little use of the file will allow the panel to become stretched.)

METAL FINISHING
UNIT III

JOB SHEET #3--GRIND, PICK, AND FILE A HIGH CROWN PANEL

I. Tools, equipment, and materials

   A. Sharp pick hammer

   B. Body file

   C. Portable grinder

   D. Goggles or safety glasses

   E. Gloves (cotton)

   F. 16 or 24 grit closed coat grinding disc

   G. Protective tape

   H. Chalk

II. Procedure

   A. Tape areas, moldings, bumper, and adjacent panels

   (NOTE: This helps prevent damage due to accidental creeping of grinder, sander, or body file.)

   B. Disc surface

   (NOTE: Buffing (Job Sheet #1) should have already been accomplished.)

   C. Locate low spots

      1. Feel with gloved hand or cotton cloth

      2. Mark with chalk

JOB SHEET #3

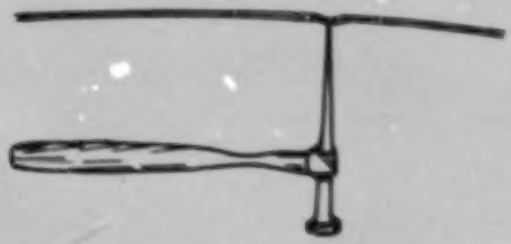
D. Pick up low areas (Figure 1)

   1. Locate the area

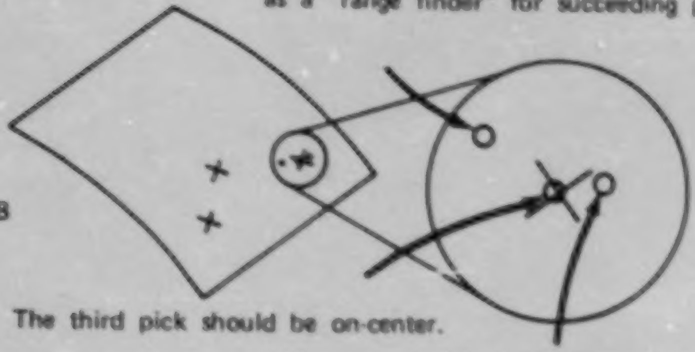
   2. Pick up the area

FIGURE 1

To practice, place three or more cross marks on a practice panel as shown and then try to "pick" them up. These marks need not be dents.



The first pick is very light and is used as a "range finder" for succeeding picks.



The third pick should be on-center.

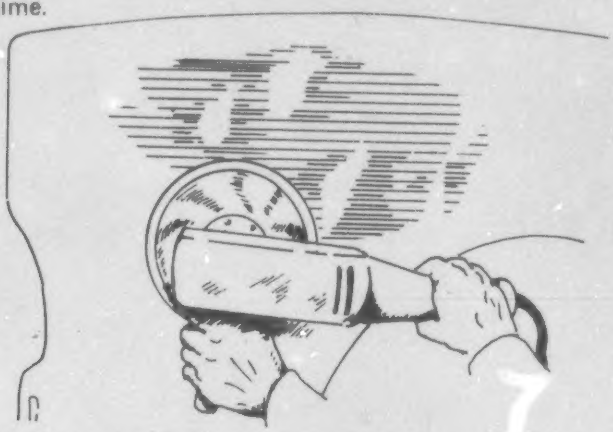
The second pick is harder and if not on-center can be used to guide the next.

JOB SHEET #3

E. Crosscut the surface (Figure 2)

FIGURE 2

Once the paint is removed, straightening and discing can continue. The fender is in the finishing stage of the repair. Picking and discing are combined here. There is a special discing action (called "crosscut") and disc used at this time.



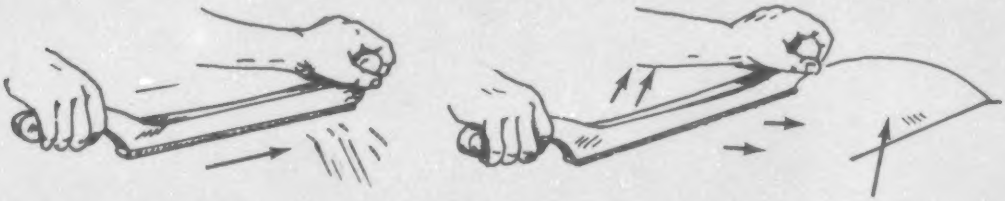
(NOTE: Picking and discing action should be done until surface feels smooth. Do not try to finish the panel with the grinder, because it will not do precision work.)

F. File the panel (Figure 3)

FIGURE 3

Held Straight With Length Of Crown And Pushed Straight

Or Held Straight With Length Of Crown And Pushed To Either Side At A 30° Angle Or Less



Crowned Area Of Fender

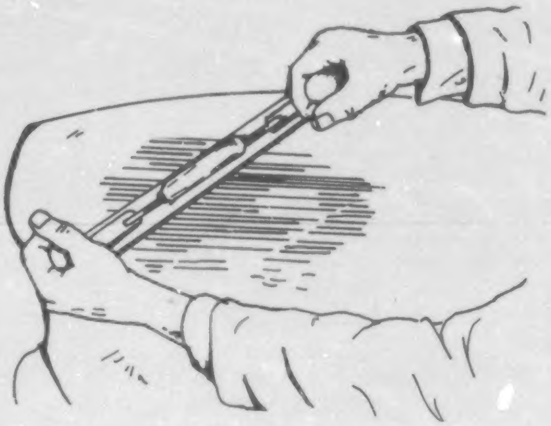
1. Pick up low spots

JOB SHEET #3

2. Check file surface
   a. X filing
   b. Cross filing (Figures 4 and 5)

(NOTE: The beginning student should concentrate on using the file. Too much use of the pick hammer and too little use of the file will allow the panel to become stretched.)

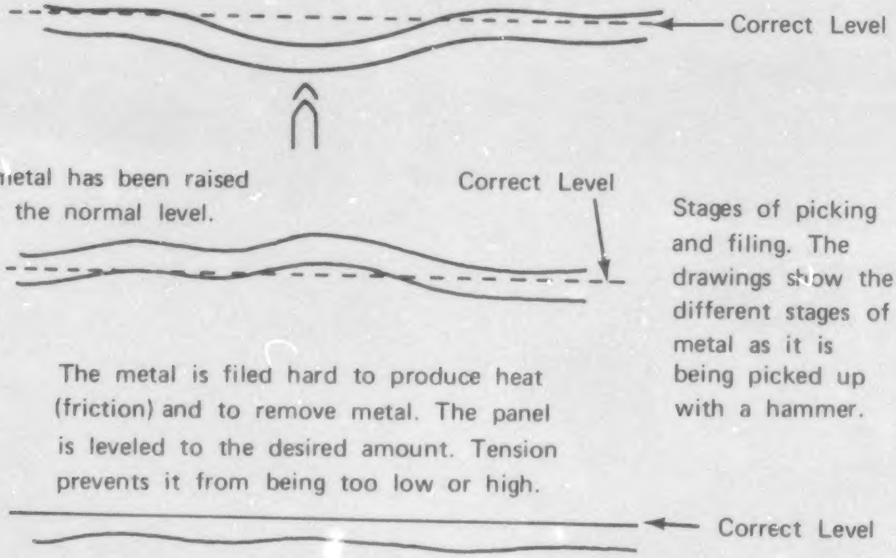
FIGURE 4



The disc cannot be used beyond this stage for straightening but will later be used for "polishing." The file must now take over the work. Picking and filing continue until the metal is completely straight. Special methods of filing are done at this time.

FIGURE 5

The metal is low and irregular. It is picked up at its lowest point.



The metal has been raised above the normal level.

Stages of picking and filing. The drawings show the different stages of metal as it is being picked up with a hammer.

The metal is filed hard to produce heat (friction) and to remove metal. The panel is leveled to the desired amount. Tension prevents it from being too low or high.

METAL FINISHING
UNIT III

JOB SHEET #4--GRIND, PICK, AND FILE A REVERSE CROWN PANEL

I. Tools, equipment, and materials

- A. Sharp pick hammer
- B. Body file (half round)
- C. Portable grinder
- D. Goggles or safety glasses
- E. Gloves (cotton)
- F. 16 or 24 grit closed coat grinding disc
- G. Protective tape
- H. Chalk

II. Procedure

A. Tape areas, moldings, bumper, a[illegible] panels

(NOTE: This helps prevent damage due to accidental creeping of grinder, sander, or body file.)

B. Disc surface

(NOTE: Buffing (Job Sheet #1) should have already been accomplished.)

C. Locate low spots

1. Feel with gloved hand or cotton cloth
2. Mark with chalk

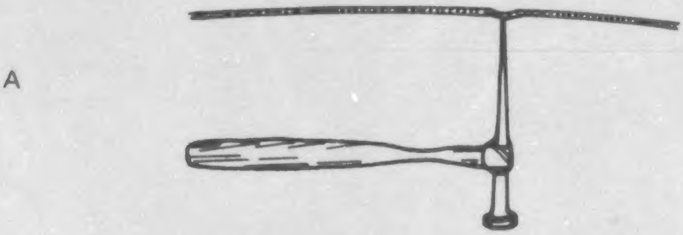
JOB SHEET #4

D. Pick up low areas (Figure 1)

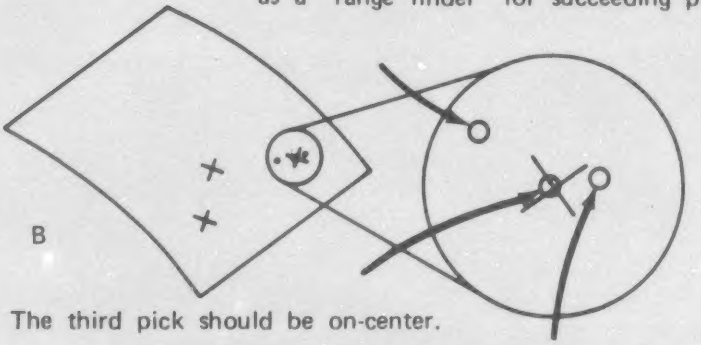
1. Locate the area
2. Pick up the area

FIGURE 1

To practice, place three or more cross marks on a practice panel as shown and then try to "pick" them up. These marks need not be dents.



The first pick is very light and is used as a "range finder" for succeeding picks.



The third pick should be on-center.

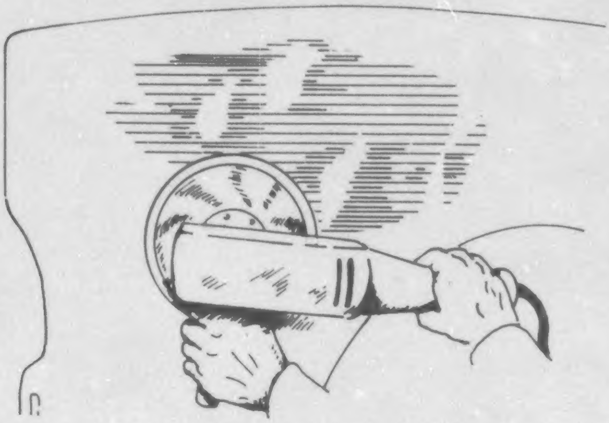
The second pick is harder and if not on-center can be used to guide the next.

JOB SHEET #4

E. Crosscut the surface (Figure 2)

FIGURE 2

Once the paint is removed, straightening and discing can continue. The fender is in the finishing stage of the repair. Picking and discing are combined here. There is a special discing action (called "crosscut") and disc used at this time.

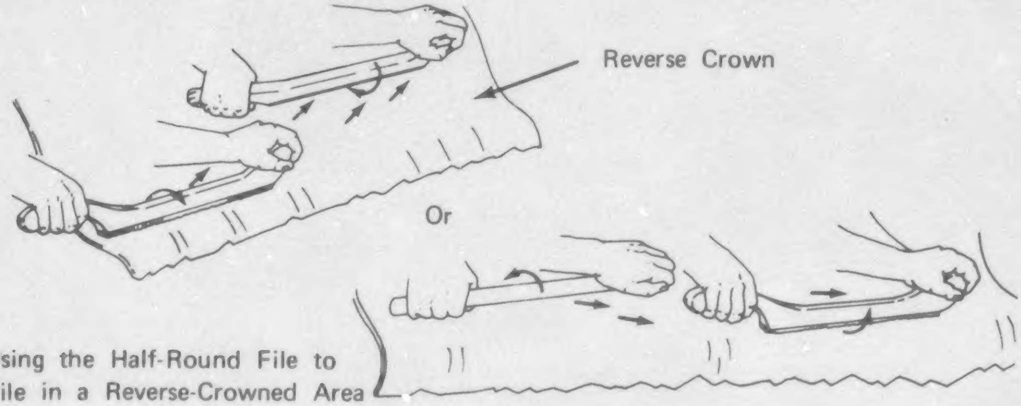


(NOTE: Picking and discing action should be done until surface feels smooth. Do not try to finish the panel with the grinder, because it will not do precision work.)

F. File the panel (Figure 3)

FIGURE 3

Hold The File Straight In Line With The Reversed Crown And Push It From The Lowest Part Outward At A 30° Angle



Using the Half-Round File to File in a Reverse-Crowned Area

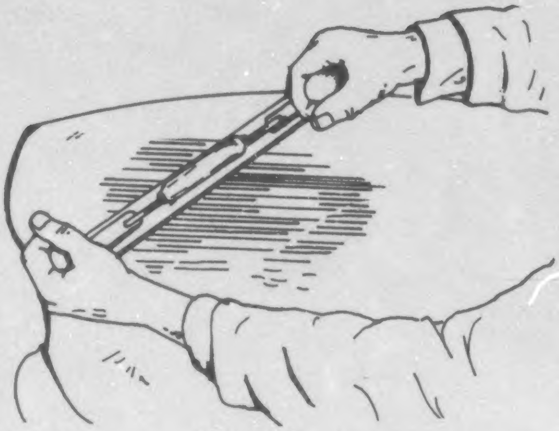
Push It From The Outside Toward The Lowest Part Of The Reversed Crown At A 30° Angle

JOB SHEET #4

1. Pick up low spots
2. Check file surface
   a. X file
   b. Cross filing (Figures 4 and 5)

FIGURE 4

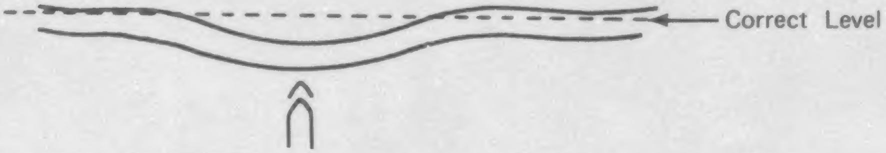
The disc cannot be used beyond this stage for straightening but will later be used for "polishing." The file must now take over the work. Picking and filing continue until the metal is completely straight. Special methods of filing are done at this time.



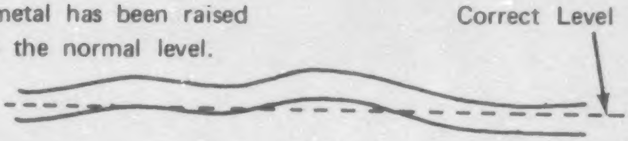
(NOTE: The beginning student should concentrate on using the file. Too much use of the pick hammer and too little use of the file will allow the panel to become stretched.)

FIGURE 5

The metal is low and irregular. It is picked up at its lowest point.

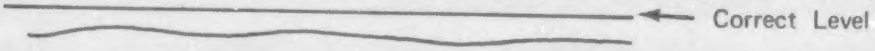


The metal has been raised above the normal level.



Stages of picking and filing. The drawings show the different stages of metal as it is being picked up with a hammer.

The metal is filed hard to produce heat (friction) and to remove metal. The panel is leveled to the desired amount. Tension prevents it from being too low or high.



METAL FINISHING
UNIT III

JOB SHEET #5--GRIND, PICK, AND FILE A GROOVE

I. Tools, equipment, and materials

  A. Sharp pick hammer

  B. Body file (half round)

  C. Portable grinder

  D. Goggles or safety glasses

  E. Gloves (cotton)

  F. 16 or 24 grit closed coat grinding disc

  G. Protective tape

  H. Chalk

II. Procedure

  A. Tape areas, moldings, bumper, and adjacent panels

  (NOTE: This helps prevent damage due to accidental creeping of grinder, sander, or body file.)

  B. Disc surface

  (NOTE: Buffing (Job Sheet #1) should have already been accomplished.)

  C. Locate low spots

    1. Feel with gloved hand or cotton cloth

    2. Mark with chalk

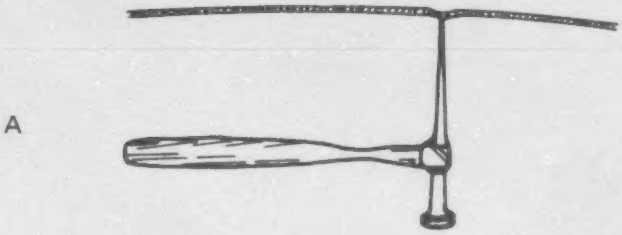
JOB SHEET #5

D. Pick up low areas (Figure 1)

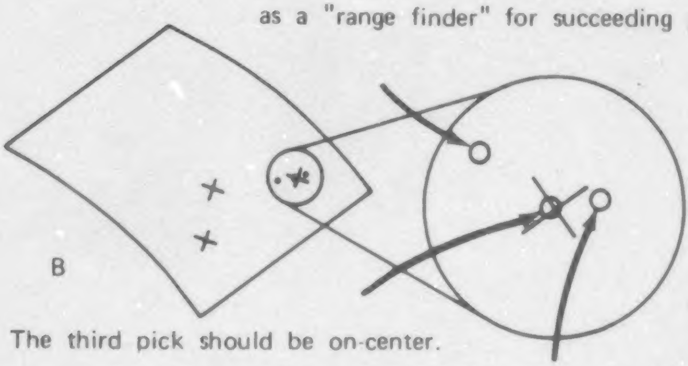
1. Locate the area
2. Pick up the area

FIGURE 1

To practice, place three or more cross marks on a practice panel as shown and then try to "pick" them up. These marks need not be dents.



The first pick is very light and is used as a "range finder" for succeeding picks.



The third pick should be on-center.

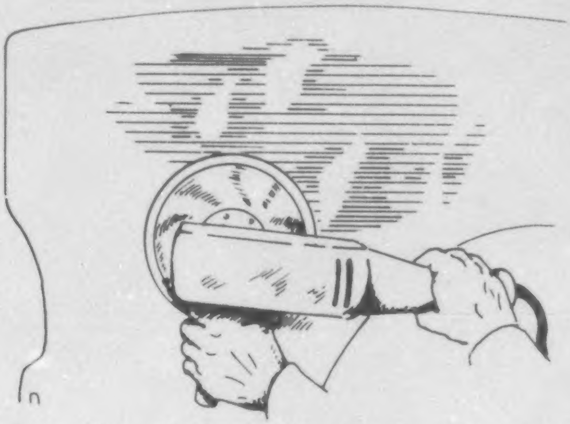
The second pick is harder and if not on-center can be used to guide the next.

JOB SHEET #5

E. Crosscut the surface (Figure 2)

Once the paint is removed, straightening and discing can continue. The fender is in the finishing stage of the repair. Picking and discing are combined here. There is a special discing action (called "crosscut") and disc used at this time.

FIGURE 2

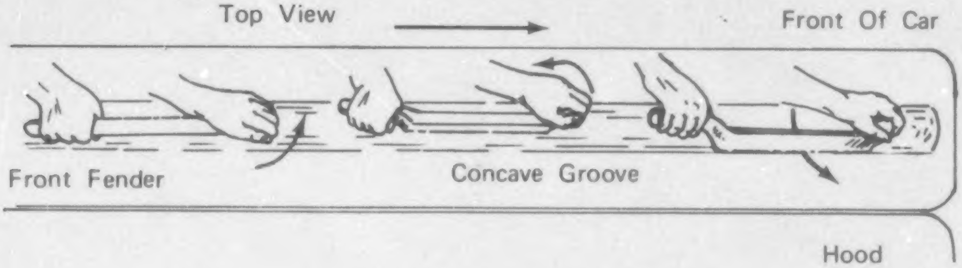


(NOTE: Picking and discing action should be done until surface feels smooth. Do not try to finish the panel with the grinder, because it will not do precision work.)

F. File the panel (Figure 3)

FIGURE 3

The Half-Round File Is Rolled from One Side of the Blade to the Other as It Is Pushed Down the Length of the Curve



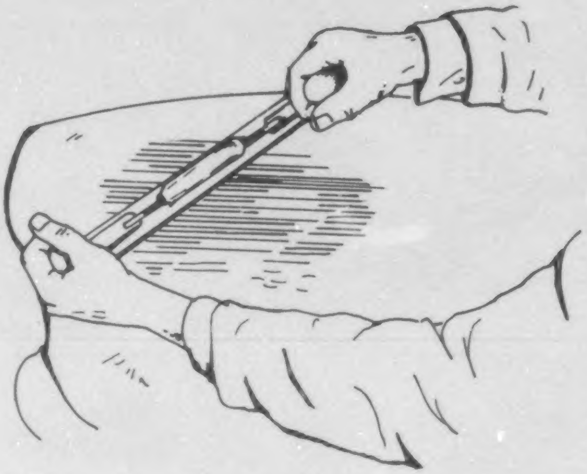
1. Pick up low spots

JOB SHEET #5

2. Check file surface
   a. X filing
   b. Cross filing (Figures 4 and 5)

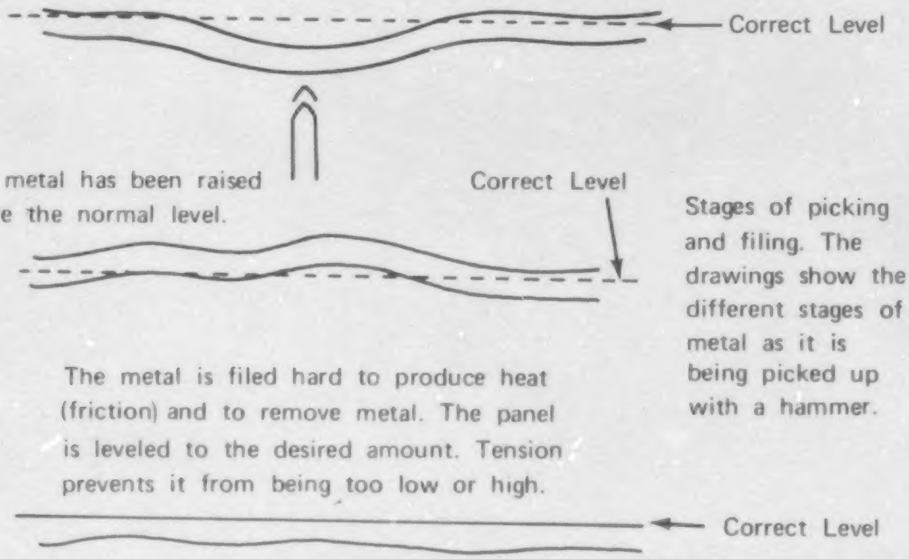
FIGURE 4

The disc cannot be used beyond this stage for straightening but will later be used for "polishing." The file must now take over the work. Picking and filing continue until the metal is completely straight. Special methods of filing are done at this time.



(NOTE: The beginning student should concentrate on using the file. Too much use of the pick hammer and too little use of the file will allow the panel to become stretched.)

FIGURE 5



The metal is low and irregular. It is picked up at its lowest point.

The metal has been raised above the normal level.

The metal is filed hard to produce heat (friction) and to remove metal. The panel is leveled to the desired amount. Tension prevents it from being too low or high.

Stages of picking and filing. The drawings show the different stages of metal as it is being picked up with a hammer.

METAL FINISHING
UNIT III

JOB SHEET #6--FINISH BUFF

I. Tools, equipment, and materials

   A. Portable body grinder

   B. Gloves

   C. Goggles or glasses

   D. 50 grit open coat grinding disc

   E. Protective tape

II. Procedure

   A. Tape areas, moldings, bumper, and adjacent panels

   (NOTE: This helps prevent damage due to accidental creeping of grinder, sander, or body file.)

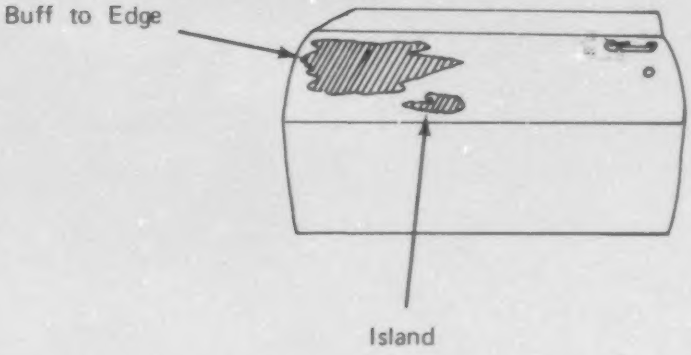
   B. Finish buff on the repaired areas

      1. Never leave islands--Small metal worked areas surrounded by paint or a paint area in the center of metal worked areas.

      2. Buff completely to the edge of a panel; do not leave a strip between metal worked area and edge (Figure 1)

FIGURE 1

This is Not the Correct Method

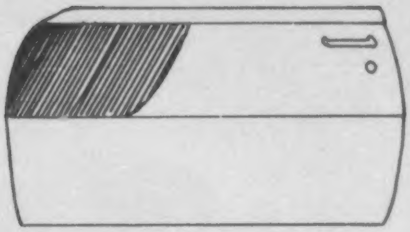


JOB SHEET #6

3. Do not buff up to attached parts, remove them
   a. Moldings
   b. Trim
4. Finish buffing in a straight line (Figure 2)

FIGURE 2

This is the Correct Method



Finishing Pattern for Discing Paint.

METAL FINISHING
UNIT III

TEST

1. Match the following terms to a list of definitions.

_____a. Pattern the abrasive cuts into the metal when grinding

_____b. Grinding motion is from side to side using the top of the disc only

_____c. Finish grinding with a fine disc to obtain a smooth surface after metal finishing is complete

_____d. File used to file convex and reverse curves

_____e. Paper, cloth, or fibre that the abrasive is bonded to

_____f. Using the pick hammer to raise metal during grinding and filing of metal finishing

_____g. Filing in one direction only

_____h. Grinding motion where grinder is moved up and down using the the top portion of the grinding disc

_____i. Disc used for grinding paint off the surface and any other coating which might plug up and ruin a closed coat disc

_____j. Filing in one direction followed by filing a second time across the first at a 45° angle; method of check filing

_____k. Disc cut special to clean damaged areas and welds

_____l. Filing in one direction followed by filing a second time across the first at a 90° angle the other direction; method of check filing

_____m. Disc used for grinding metal after paint has been removed

1. Buffing
2. Crosscutting (discing)
3. Metal polishing
4. Crosscut
5. Closed coat disc
6. Open coat disc
7. Backing
8. Hexagon or square cut disc
9. Picking
10. Cross filing
11. X filing
12. Line filing
13. Half round or shell file

2. Name two types of grinders used in body sheet metal repair.

   a.

   b.

3. List three uses of a body grinder.

   a.

   b.

   c.

4. State the angle of contact of the disc off the metal.

5. Describe the buffing method when using the body grinder.

6. Describe crosscutting when using the body grinder.

7. Describe metal polishing when using the body grinder.

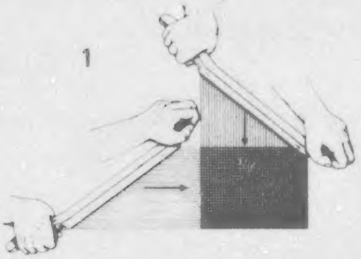
8. Match the filing hatch patterns to the filing methods.

_____a. Cross filing

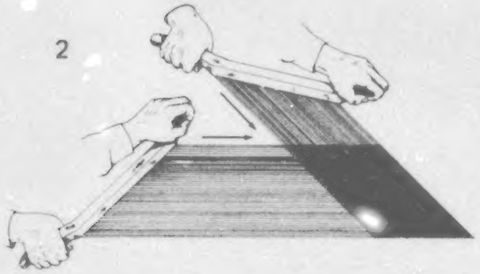
_____b. Line filing

_____c. X filing

1



2



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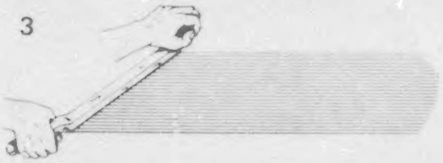


9. Describe the method of picking up low spots.

10. Describe how to locate low and high spots.

11. Demonstrate the ability to:

a. Remove paint from a damaged area on a body panel by buffing.

b. Grind, pick, and file a flat panel.

c. Grind, pick, and file a high crown panel.

d. Grind, pick, and file a reverse crown panel.

e. Grind, pick, and file a concave groove.

f. Finish buff.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

METAL FINISHING
UNIT III

ANSWERS TO TEST

1. a. 4

   b. 2

   c. 3

   d. 13

   e. 7

   f. 9

   g. 12

   h. 1

   i. 6

   j. 10

   k. 8

   l. 11

   m. 5

2. a. Electric sander or grinder

   b. Pneumatic sander or grinder

3. a. Buffing

   b. Crosscutting

   c. Metal polishing

4. 10° to 20°

5. The grinder should move up and down panel using top portion of the disc; each cut of the disc should overlap the first

6. Grinder should move from side to side using the right side of the disc; the crosscut of the disc will make an "X" angle to the first during each pass of the grinder

7. The finish buffing of metal to remove coarse disc and file scratches preparing the finish for the painter

8. a. 1

   b. 3

   c. 2

9. Accomplished with a very sharp nosed pick hammer

10. a. Feel the surface with a cotton glove or cloth to detect surface imperfections

    b. File scratch pattern to locate low and high spots

11. Performance skills will be evaluated according to the criteria listed on the progress chart.

SHRINKING
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define the terms associated with the shrinking process and explain hot and cold shrinking of automobile metal. He should be able to shrink stretched automobile metal using the appropriate method. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with shrinking to a list of definitions.
2. List four steps of hot shrinking.
3. List three reasons body repairmen need to use proper heat in shrinking metal.
4. Describe when quenching, as a means of controlling the rate of cooling, is necessary.
5. Describe the use of a slapping spoon in shrinking metal.
6. Describe the use of a shrinking dolly and hammer to shrink metal.
7. Demonstrate the ability to:
    a. Hot shrink raised metal.
    b. Hot shrink gouged metal.
    c. Cold shrink with a slapping spoon.
    d. Cold shrink with a shrinking hammer and dolly.

SHRINKING
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in job sheets.
   G. Give test.

II. Student:
   A. Read objective sheet.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objective sheet
   B. Information sheet
   C. Transparency masters
      1. TM 1--Hot Shrinking
      2. TM 2--Cold Shrinking Using a Slapping Spoon
      3. TM 3--Cold Shrinking Using a Cross Peen Hammer and Dolly

D. Job sheets

  1. Job Sheet #1--Hot Shrink Raised Metal

  2. Job Sheet #2--Hot Shrink Gouged Metal

  3. Job Sheet #3--Cold Shrink Using a Slapping Spoon

  4. Job Sheet #4--Cold Shrink Using a Shrinking Hammer and Dolly

E. Test

F. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Company of Canada, Limited, 1969.

B. McPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Book Company, Inc., 1971.

C. Richert, Melvin T. *How to Control Auto Body Sheet Metals,* First Edition. Philadelphia, Pennsylvania: Chilton Book Company, 1968.

D. Sargent, Robert L. *Automobile Sheet Metal Repair,* Second Edition. Philadelphia, Pennsylvania: Chilton Book Company, 1969.

E. Spicer, Edward D. *Automotive Collision Work,* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

SHRINKING
UNIT IV

INFORMATION SHEET

I. Terms and definitions

   A. Hot shrinking--Operation where heat is used to soften metal to permit the desired upset to be made

   B. Cold shrinking--Operation where stretched metal is drawn back to contour by forcing it into the concave side of a shrinking dolly with a cross peen hammer

   C. Sinking welds--Operation using the shrinking dolly and cross peen hammer to lower welds

   (NOTE: After weld is lowered, it is filled using body lead or plastic filler.)

   D. High spot--Stretched spot in a body panel

   E. Gouge--Metal stretched on impact, usually the direct damage area of a damaged panel

   F. Over shrinking--Result of shrinking some of the temporarily expanded metal in addition to that which was stretched

   G. Quenching--Cooling a shrink spot with a damp sponge or cloth

   H. False stretch--Where an upset has caused an adjoining area to bulge so that it appears to be stretched

II. The four steps of hot shrinking (Transparency 1)

   A. Heat the stretched spot expanding and softening the metal

   B. Drive down the softened high spot

   C. Straighten the shrink area using the hammer and dolly

   D. Quench the hot metal with water

III. Reasons proper heat must be used to shrink metal

   A. In underheating, the metal will not soften and upset cannot occur

   B. In overheating, the metal (hot spot) will collapse forming a depression

   C. Proper heat will result in a low temperature spreading over the entire area producing a uniform upset and a smooth surface

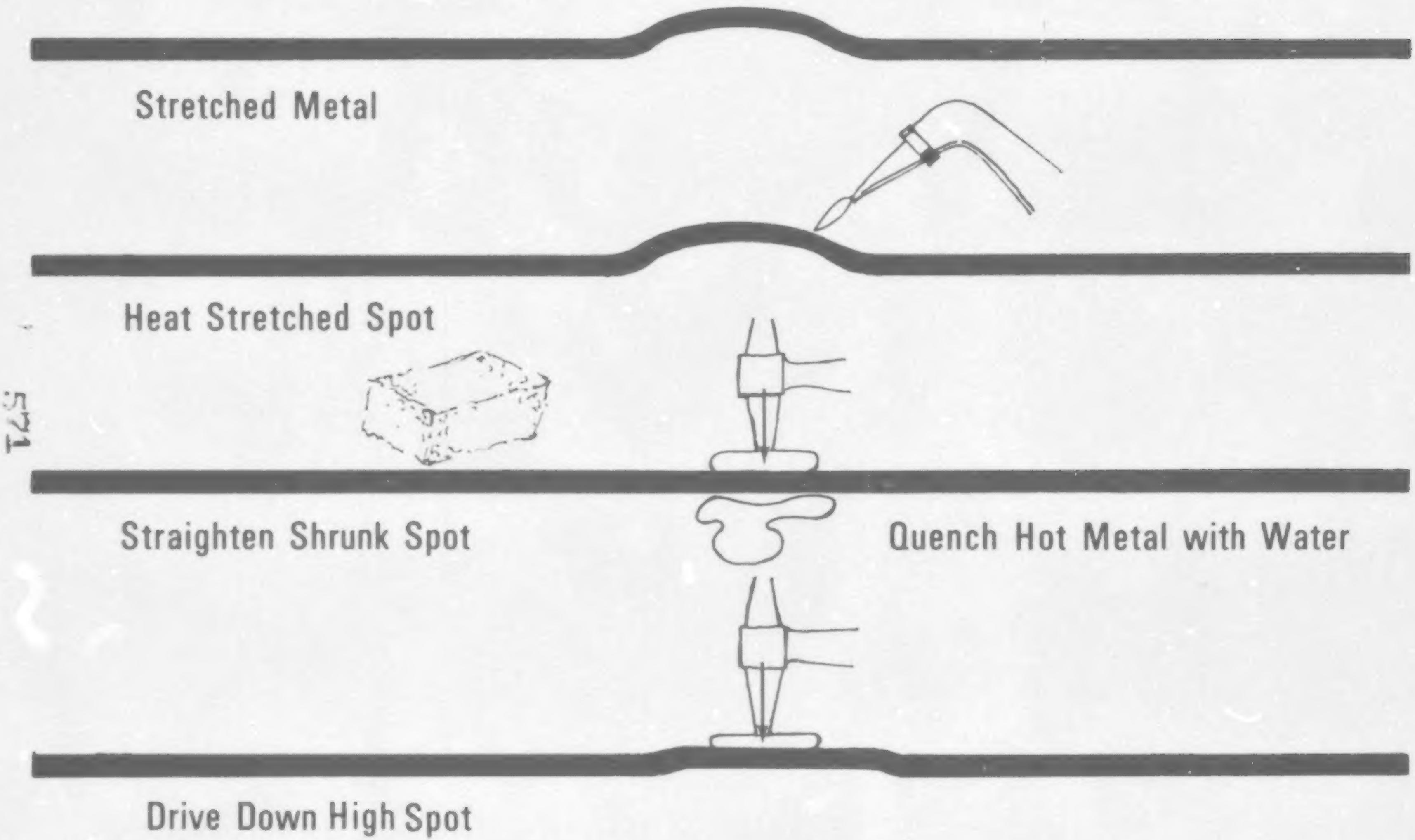
INFORMATION SHEET

IV. Use of quenching--Necessary when a greater amount of upset is required than if the metal was allowed to cool slowly after shrinking

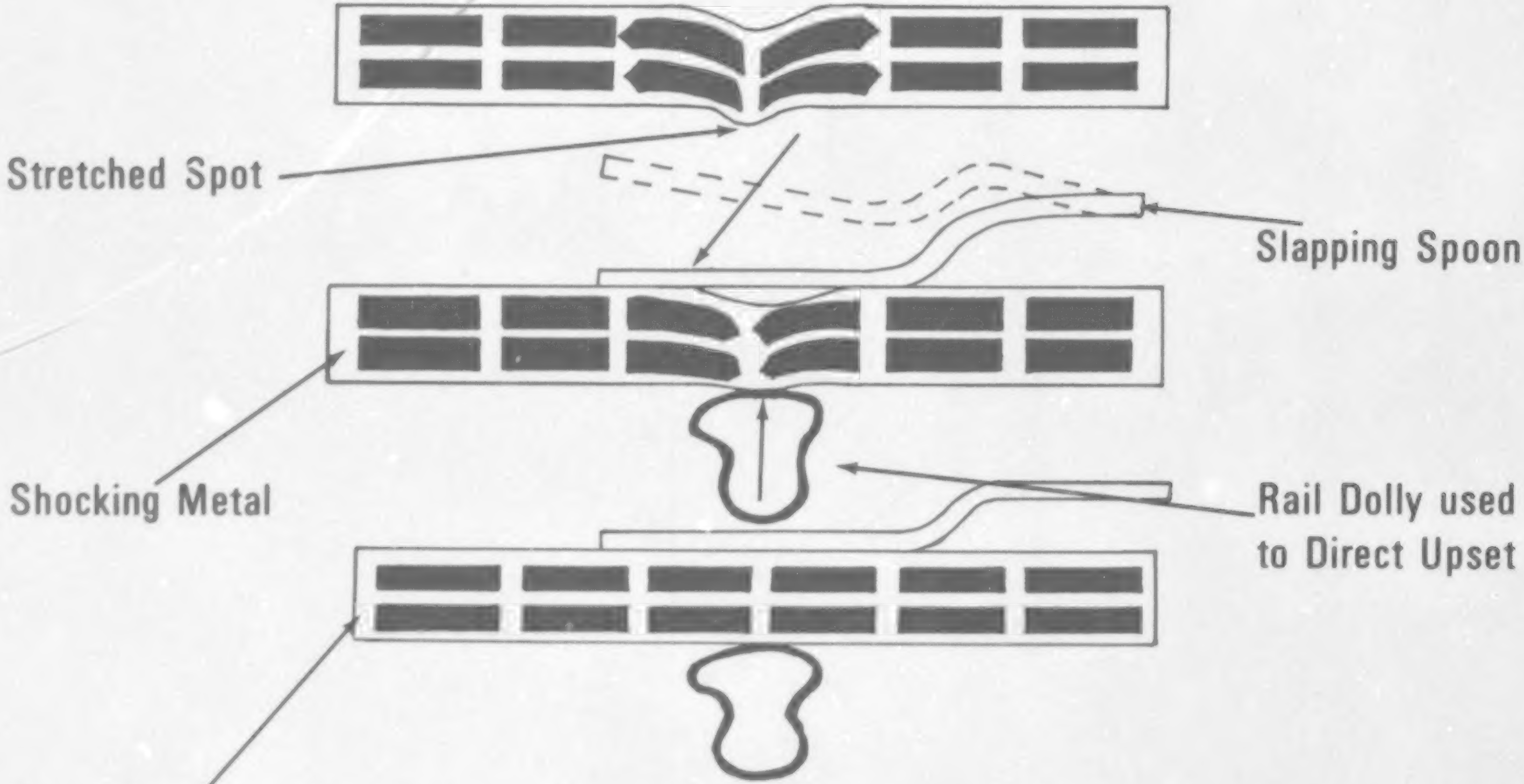
V. Use of slapping spoon--Used in conjunction with a dolly to shock a stretched area back to its position (Transparency 2)

VI. Use of a shrinking dolly--Used with a cross peen hammer to drive the metal into the concave part of the dolly until the stretched metal is drawn back to its proper position (Transparency 3)

Hot Shrinking


Stretched Metal
Heat Stretched Spot
Straighten Shrunk Spot
Quench Hot Metal with Water
Drive Down High Spot

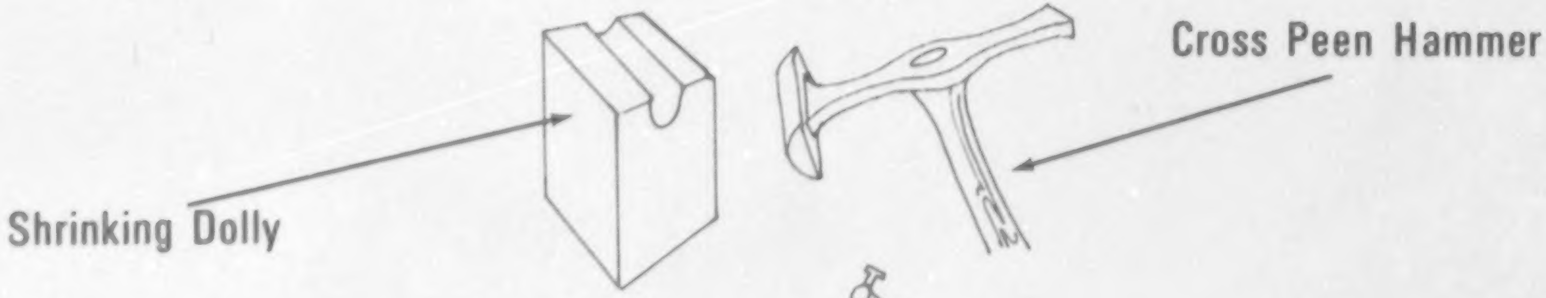
Cold Shrinking Using a Slapping Spoon

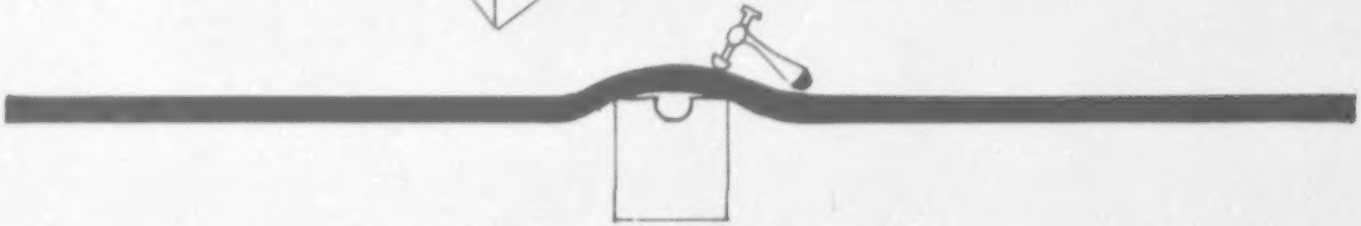

Stretched Spot
Slapping Spoon
Shocking Metal
Rail Dolly used
to Direct Upset
Metal Returns to Normal

TM 2

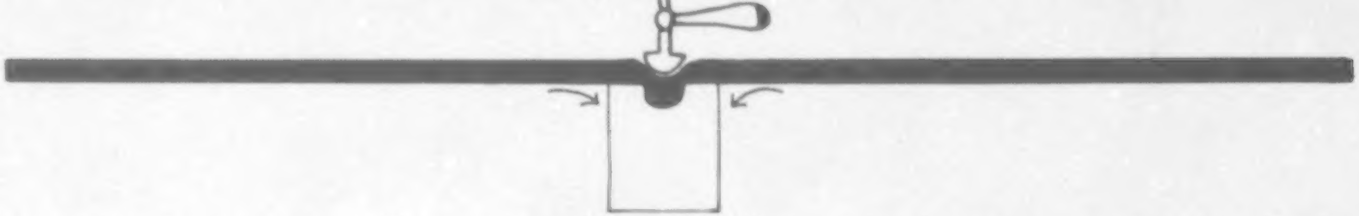
181-F

Cold Shrinking Using a Cross Peen Hammer and Dolly

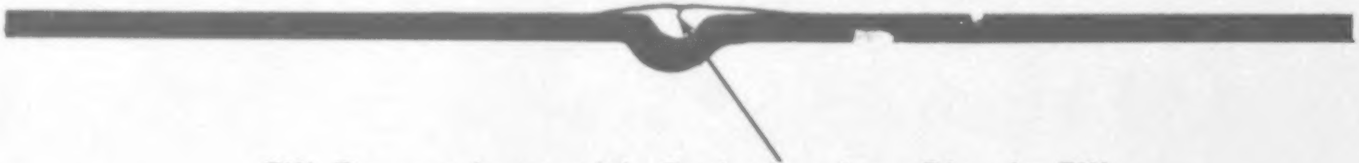

Shrinking Dolly
Cross Peen Hammer



Place Dolly Under Stretched Area



Drive Metal down into Concave Area Allowing Panel to Regain its Proper Contour



Fill Depressions with Body Lead or Plastic Filler

SHRINKING
UNIT IV

JOB SHEET #1--HOT SHRINK RAISED METAL

I. Tools and equipment

- A. Shrinking hammer
- B. Shrinking dolly block
- C. Water pail
- D. Sponge
- F. Oxyacetylene torch
- G. Gloves (welding)

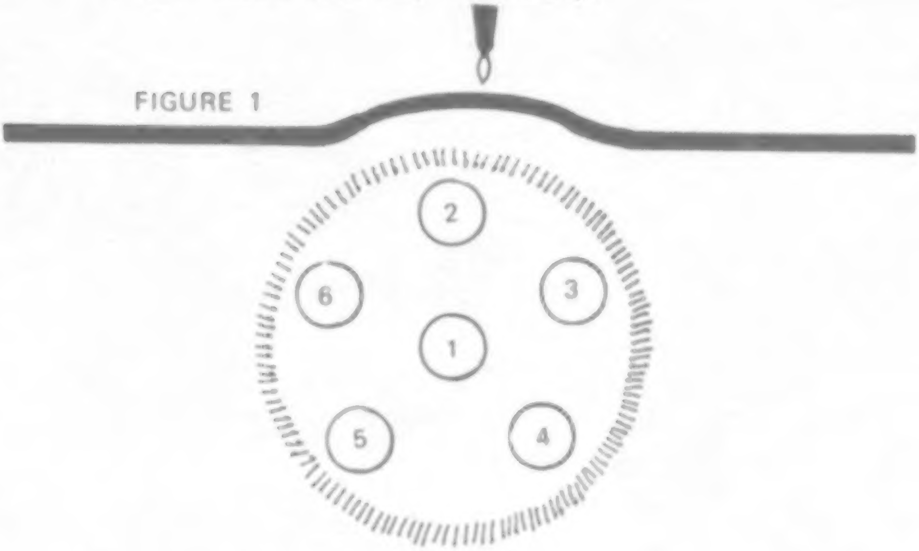
II. Procedure

- A. Heat a spot at the center of bulge (Figure 1)

  (IMPORTANT: Use a neutral flame and wear gloves.)

  (NOTE: Several spots may be necessary.)

FIGURE 1

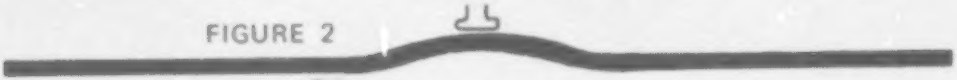


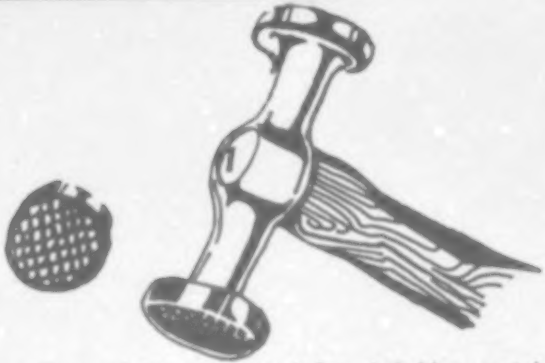
When shrinking metal by heat, first heat a spot at the center of the bulge and continue as shown by the numbered spots.

JOB SHEET #1

B. Drive down softened high spot using a shrinking hammer (Figure 2)

FIGURE 2

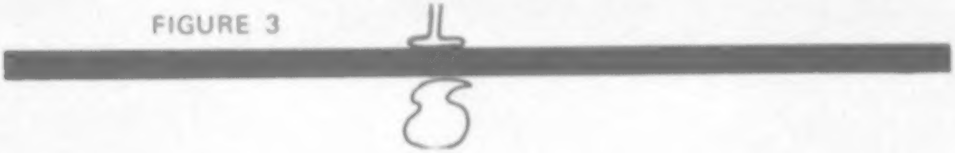




Face of hammer used for shrinking metal. Note that face is cross-grooved.

C. Straighten the shrunk area using hammer and dolly (Figure 3)

FIGURE 3



D. Quench hot metal with wet sponge (Figure 4)

FIGURE 4

(NOTE: It is not always desirable to quench the shrunk panel. Too much contraction due to cooling could cause the panel to buckle.)

SHRINKING
UNIT IV

JOB SHEET #2--HOT SHRINK GOUGED METAL

I. Tools and equipment

- A. Shrinking hammer
- B. Shrinking dolly block
- C. Extended dolly block
- D. Pry tools
- E. Water pail
- F. Sponge
- G. Oxyacetylene torch
- H. Gloves (welding)

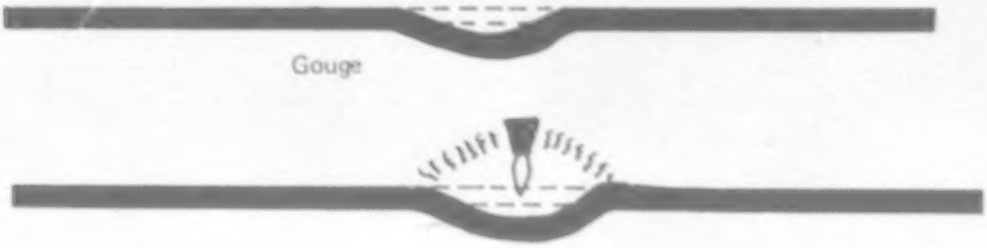
II. Procedure

A. Heat the gouge (Figure 1)

(NOTE: When shrinking a gouge, heat the entire length.)

(IMPORTANT: Use a neutral flame and wear gloves.)

FIGURE 1

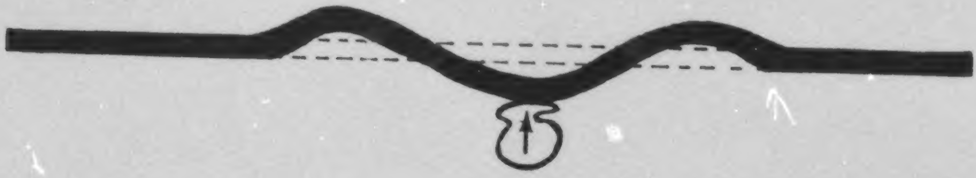


JOB SHEET #2

B. Drive up the heated area using the dolly block (Figure 2)

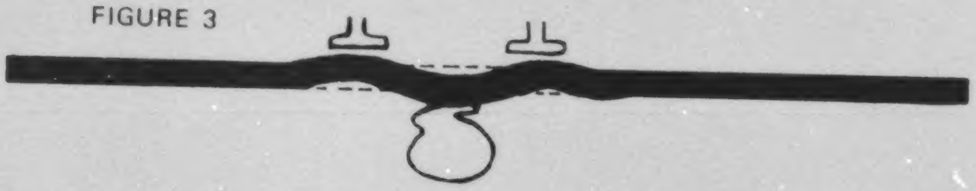
(NOTE: If spot is not accessable, a pry tool or extended dolly might have to be used.)

FIGURE 2



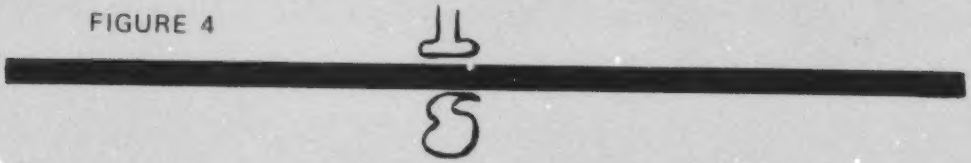
C. Level the high and low spots--Hammer off the dolly technique (Figure 3)

FIGURE 3



D. Relieve overshrinking--Hammer on the dolly technique (Figure 4)

FIGURE 4



E. Quench the hot metal (Figure 5)

(NOTE: It is not always desirable to quench the shrunk panel. Too much contraction due to cooling could cause the panel to buckle.)

FIGURE 5

SHRINKING
UNIT IV

JOB SHEET #3--COLD SHRINK USING A SLAPPING SPOON

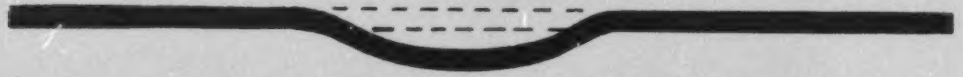
I. Tools and equipment

- A. Slapping spoon
- B. All purpose dolly

II. Procedure

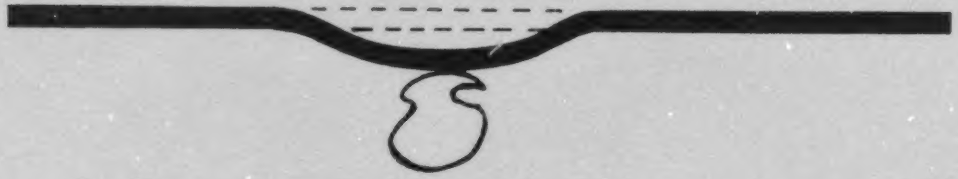
A. Locate stretch area (Figure 1)

FIGURE 1



B. Place dolly under lowest point of indentation (Figure 2)

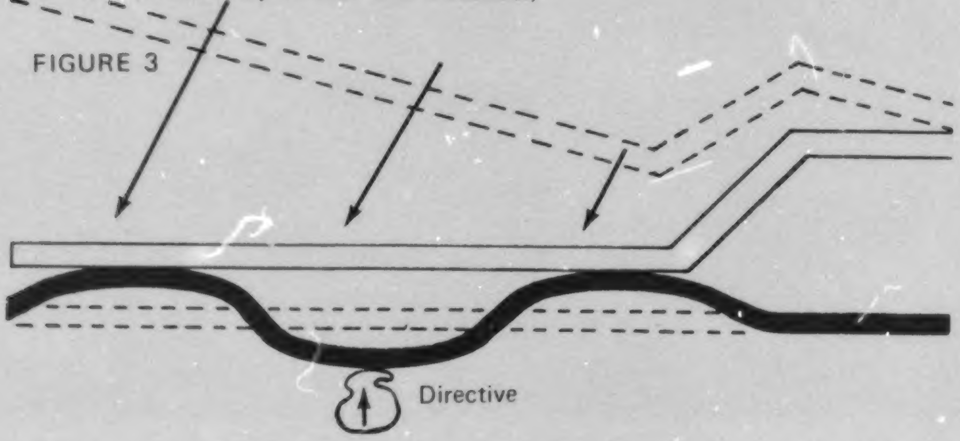
FIGURE 2



C. Slap panel with slapping spoon (Figure 3)

(NOTE: This action shocks the metal allowing it to return to normal position by release and directive.)

FIGURE 3

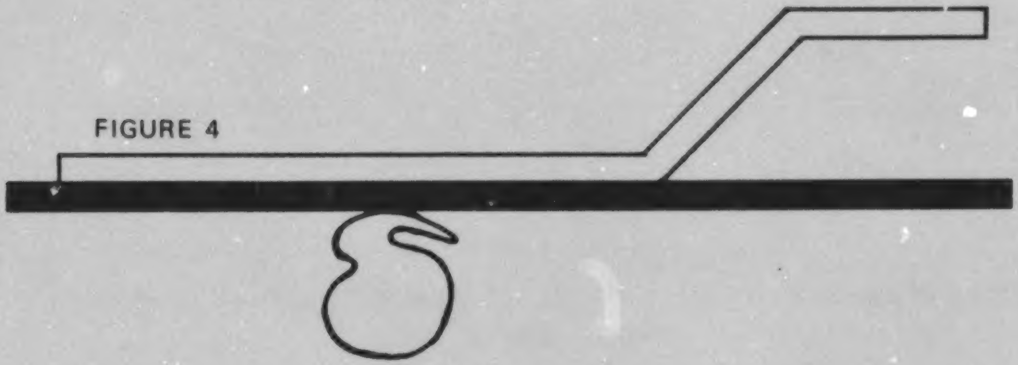


JOB SHEET #3

D. Metal returns to normal position (Figure 4)

(NOTE: Several blows with the slapping spoon may be necessary to shock the metal causing release.)

FIGURE 4



SHRINKING
UNIT IV

JOB SHEET #4--COLD SHRINK USING A SHRINKING HAMMER AND DOLLY

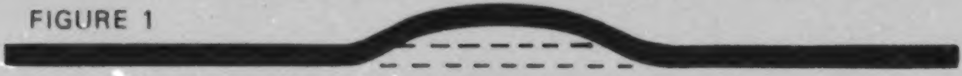
I. Tools and equipment

- A. Shrinking hammer
- B. Shrinking dolly

II. Procedure

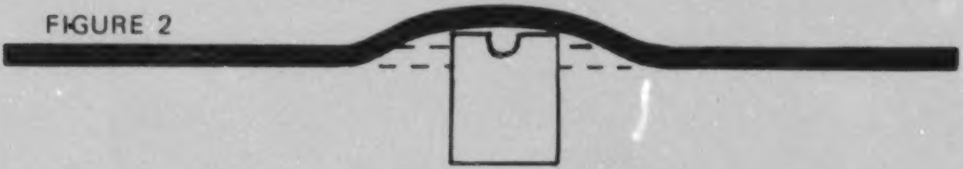
- A. Locate stretch area (Figure 1)

FIGURE 1



- B. Place shrinking dolly under stretched area (Figure 2)

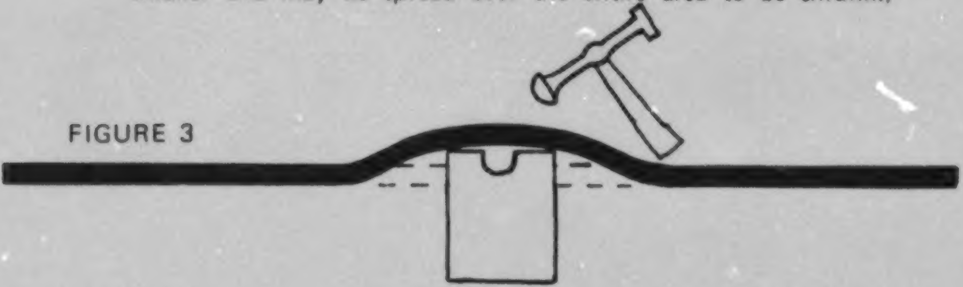
FIGURE 2



- C. Drive metal down into the concave part of shrinking dolly using the cross peen end of the shrinking hammer (Figure 3)

  (NOTE: Some body men prefer to use a pick hammer. Depressions are smaller and may be spread over the entire area to be shrunk.)

FIGURE 3

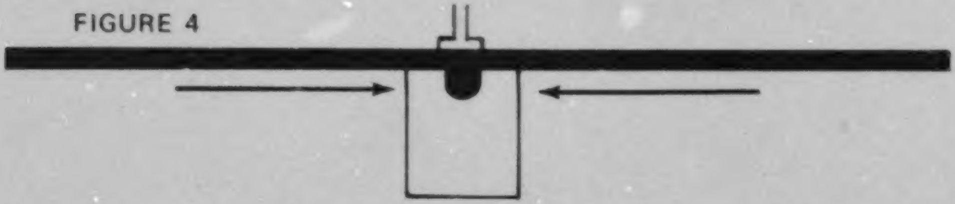


JOB SHEET #4

D. Metal returns to its proper position (Figure 4)

(NOTE: Shrinking is accomplished by drawing the stretched area into the dolly, thus, controlling it.)

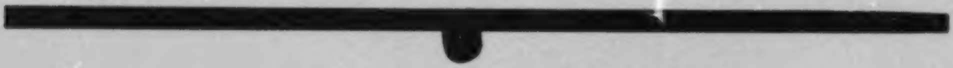
FIGURE 4



E. Fill the depression caused by drawing the stretched metal into the shrinking dolly (Figure 5)

(NOTE: Either body lead or plastic filler may be used.)

FIGURE 5



SHRINKING
UNIT IV

TEST

1. Match the terms associated with shrinking to the list of definitions.

_____a. Operation where heat is used to soften metal to permit the desired upset to be made

_____b. Operation where metal is drawn back to contour by forcing it into the concave side of a shrinking dolly with a cross peen hammer

_____c. Operation using the shrinking dolly and cross peen hammer to lower welds

_____d. Stretched spot in a body panel

_____e. Metal stretched on impact, usually the direct damage area of a damaged panel

_____f. Result of shrinking some of the temporarily expanded metal in addition to that which was stretched

_____g. Cooling a shrink spot with a damp sponge or cloth

_____h. Where an upset has caused an adjoining area to bulge so that it appears to be stretched

1. Sinking welds
2. Quenching
3. Gouge
4. Cold shrinking
5. False stretch
6. High spot
7. Hot shrinking
8. Over shrinking

2. List the four steps of hot shrinking.

a.

b.

c.

d.

3. List three reasons body repairmen need to use proper heat in shrinking metal.

   a.

   b.

   c.

4. Describe when quenching, as a means of controlling the rate of cooling, is necessary.

5. Describe the use of a slapping spoon in shrinking metal.

6. Describe the use of a shrinking dolly and hammer to shrink metal.

7. Demonstrate the ability to:

   a. Hot shrink raised metal.

   b. Hot shrink gouged metal.

   c. Cold shrink with a slapping spoon

   d. Cold shrink with a shrinking hammer and dolly.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

SHRINKING
UNIT IV

ANSWERS TO TEST

1. a. 7

   b. 4

   c. 1

   d. 6

   e. 3

   f. 8

   g. 2

   h. 5

2. a. Heat the stretched spot expanding and softening the metal

   b. Drive down the softened high spot

   c. Straighten the shrink area using the hammer and dolly

   d. Quench the hot metal with water

3. a. In underheating, metal will not soften and upset cannot occur

   b. In overheating, metal will collapse forming a depression

   c. Proper heat will result in a low temperature spreading over the entire area producing a uniform upset and a smooth surface

4. Necessary when a greater amount of upset is required than if the metal was allowed to cool slowly after shrinking

5. Used with a dolly to shock a stretched area back to its position

6. Used with a cross peen hammer to drive the metal into the concave part of the dolly until the stretched metal is drawn back to its proper position

7. Performance skills will be evaluated according to the criteria listed on the progress chart.

BODY FILLING
UNIT V

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with body filling, prepare a damaged metal surface or seam, and fill with plastic body filler or with body solder as required. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with body filling to a list of definitions.
2. List seven steps in applying plastic filler.
3. List the four basic steps in applying body solder.

   List the three materials that under normal conditions will be on the surface to be soldered and must be removed.
5. Write the four steps in tinning.
6. Demonstrate the ability to:
   a. Prepare the surface for plastic filler.
   b. Mix plastic filler.
   c. Apply and finish plastic body filler.
   d. Prepare the surface for solder filler.
   e. Apply body solder.
   f. Finish file solder filler.

BODY FILLING
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Discuss terminal and specific objectives.
- D. Discuss information sheet.
- E. Discuss assignment sheets and handouts.
- F. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Job sheets
    1. Job Sheet #1--Surface Preparation for Body Plastic Filler
    2. Job Sheet #2--Mixing Plastic Filler
    3. Job Sheet #3--Applying and Finishing Plastic Body Filler
    4. Job Sheet #4--Surface Preparation for Solder Filling

5. Job Sheet #5--Application of Body Solder

6. Job Sheet #6--Solder Finishing

D. Test

E. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Company of Canada Limited, 1969.

B. McPherson, Robert C. *Collision Repair Guide*. New York: McGraw-Hill Book Company Inc., 1971.

C. Wohlfeil, Theo A. *Automobile Body Reconditioning*. New York: McGraw-Hill Book Company Inc., 1972.

BODY FILLING
UNIT V

INFORMATION SHEET

I. Terms and definitions

A. Plastic filler--Usually a polyester resin to which various fibers and other materials have been added; used to fill dents in automotive body sheet metal

B. Hardener--Usually a pigmented cream catalyst which causes the plastic filler to harden; it also causes the color to change when it is properly mixed

(NOTE: Hardner can also be found in liquid and powder forms.)

C. Metal preparation--Step in which all impurities must be removed from surface (paint, slag, rust, or others) before body filler or solder can be used

D. Kneading--Mixing action to properly blend hardener with plastic filler

E. Cheese grater--Name given to the "Stanley Shur-form File" used by body men to rough file body filler

F. Pin holes--Small holes in applied body filler due to improper mixing and too much hardener

(NOTE: Pin holes can also result from heat created by grinding the filler.)

G. Build up--Amount necessary to build the surface being filled to the proper level

H. Body solder--A lead-tin combination used to fill dents and joints in automobile bodies

I. Flux--An acid used to clean the sheet metal during the tinning procedure

J. Tinning--A step in soldering required to let the solder adhere to the metal

K. Mush pot--A pot used to keep molten body solder in a large quantity during a large filling operation

L. Air pocket--Air trapped in body filler when mixing due to improper stirring; as a result, affected plastic filler must be removed and refilled

INFORMATION SHEET

II. Applying plastic filler

- A. Clean the surface
- B. Mix plastic filler
- C. Apply a "tin" coat of filler
- D. Fill and build
- E. Rough file
- F. Skim coat
- G. Finish

III. Steps in applying body solder

- A. Clean the surface
- B. Tinning
- C. Filling and shaping
- D. Metal finishing

IV. Materials to be removed from surface

- A. Paint
- B. Weld scale
- C. Rust

V. Steps in tinning

- A. Clean the surface
- B. Apply flux

  (NOTE: Powdered fluxes (compounds) have solder ground in them and will tin as they are applied.)
- C. Heat surface and apply solder
- D. Heat area until solder melts and wipe surface with clean cloth

BODY FILLING
UNIT V

JOB SHEET #1--SURFACE PREPARATION FOR BODY PLASTIC FILLER

I. Tools, equipment, and materials

  A. Portable body grinder

  b. Drill 1/4 inch

  C. Carbon brush

  D. Discs

    1. 16 grit open coat

    2. 24 grit open coat

    3. 16 grit closed coat

    4. 24 grit closed coat

  E. Metal conditioner

II. Procedure

  A. Straighten all damaged metal

  (NOTE: All possible metal work should be accomplished before filling any part of the damaged area.)

  B. Grind the damage area

  (CAUTION: A portable body grinder turns in excess of 4000 RPM. Use proper grinding techniques. Wear gloves, safety eyeshields and glasses, or goggles. Warn others before using the grinder.)

    1. Buff off all paint eight inches beyond area to be filled

    2. Remove all slag from welds

    3. Remove all impurities from surface

    (NOTE: Use a hexagon cut disc, square cut disc,or a carbon brush to clean inaccessible areas.)

BODY FILLING
UNIT V

JOB SHEET #2--MIXING PLASTIC FILLER

I. Tools, equipment, and materials

   A. Board file

   B. Cheese grate file

   C. Putty knife

   D. Body filler and hardener

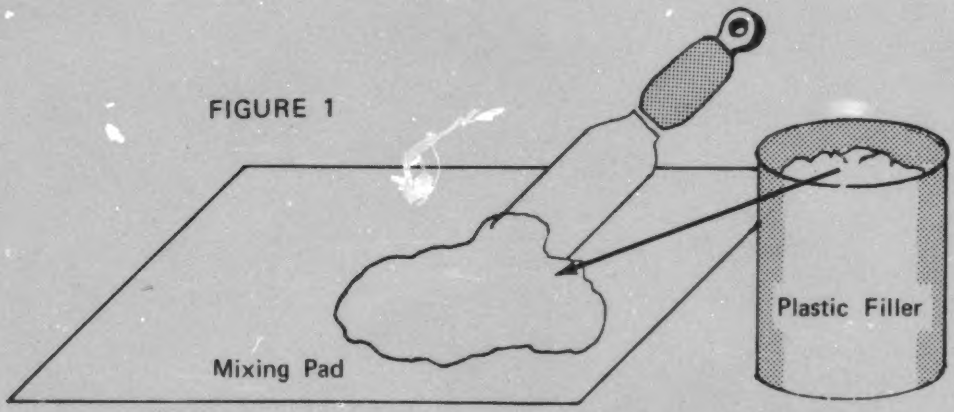
   E. Mixing pad

II. Procedure

   A. Add hardener to plastic filler

      1. Place a small amount of plastic filler on a mixing pad (Figure 1)

FIGURE 1

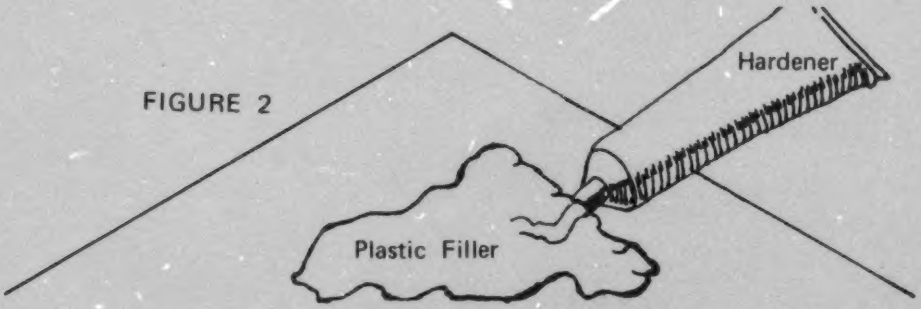


(NOTE: Many types of mixing pads are available. A one foot square piece of body sheet metal or an old safety door glass make good mixing pads. Do not use porous material. They create air bubbles in filler during mixing. Be sure container of plastic filler has been adequately stirred.)

JOB SHEET #2

2. Add hardener to plastic filler (Figure 2)

FIGURE 2

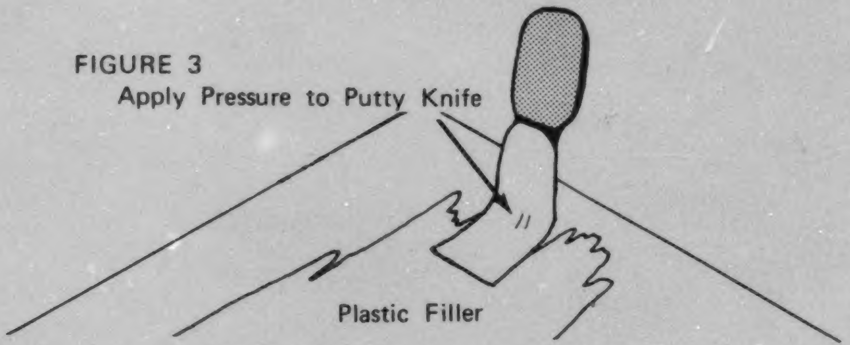

Hardener
Plastic Filler

(NOTE: For mixing plastic and hardener, follow manufacturer's recommendations.)

B. Mix body filler

1. Mix with a kneading action (Figure 3)

FIGURE 3


Apply Pressure to Putty Knife
Plastic Filler

(NOTE: Do not stir as this will result in air bubbles forming causing pinholes in the fill.)

2. Mix the plastic filler and hardener thoroughly

(NOTE: Most hardeners are tinted with pigment to change the color of the body filler. Mix until all streaks are gone. Undermixing will result in soft spots which will require doing the job over.)

BODY FILLING
UNIT V

JOB SHEET #3--APPLYING AND FINISHING PLASTIC BODY FILLER

I. Tools, materials, and equipment

  A. Putty knife

  B. Cheese grate file

  C. Board file

  D. Body filler

  E. Sandpaper

II. Procedure

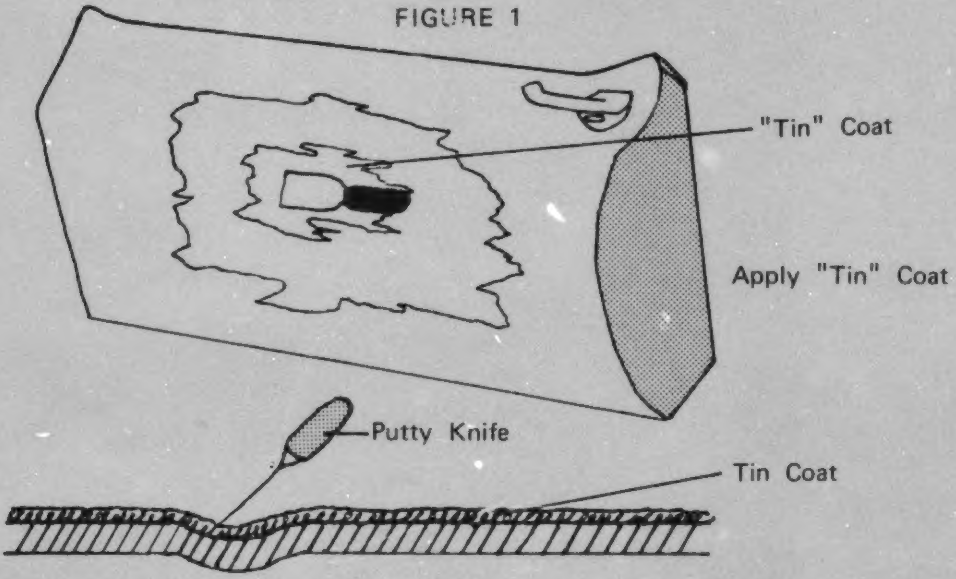
  A. Apply first coat to damaged area (Figure 1)

    1. Work thin coat (tinning coat) into the grinder marks

    (IMPORTANT: For proper adhesion, work the first coat into the scratches made by the grinder, brush, etc.)

    2. Work coat into the entire area to be filled

FIGURE 1



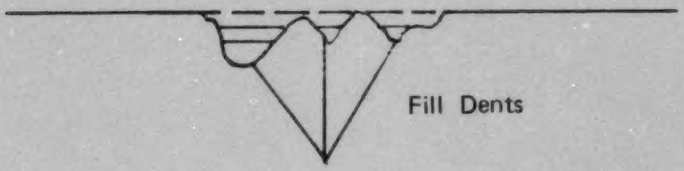
Work Thin Coat Into The Metal To Provide Maximum Adhesion

JOB SHEET #3

B. Fill deepest dents and grooves (Figure 2)

(NOTE: Let these fills dry completely to prevent dragging the fills out when applying subsequent coats.)

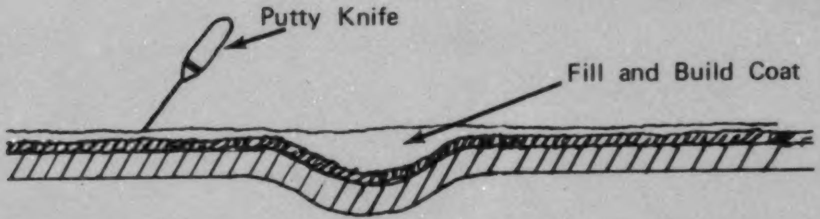
FIGURE 2



C. Fill the surface and build to desired height (Figure 3)

1. Apply coats necessary to build surface to original contours and form necessary ridges

FIGURE 3



Fill Entire Damage Area

Apply Plastic Filler

2. Rough file nubs from surface after each coat

(NOTE: Use a cheese grate file.)

(IMPORTANT: Apply several thin coats. Thick coats will create too much heat during thermal heating creating pin holes and blisters in the body filler. Fill only as much area as you can work at one time.)

JOB SHEET #3

D. Rough file

   1. Shape body filler with a cheese grate file creating normal contours or peaks (Figure 4)

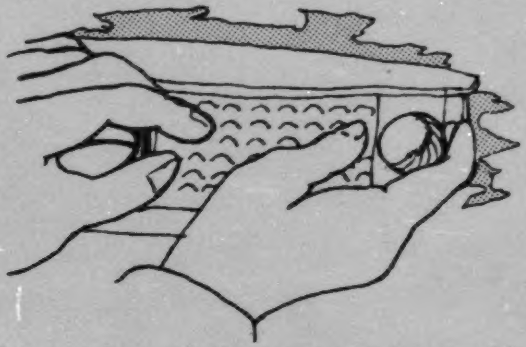
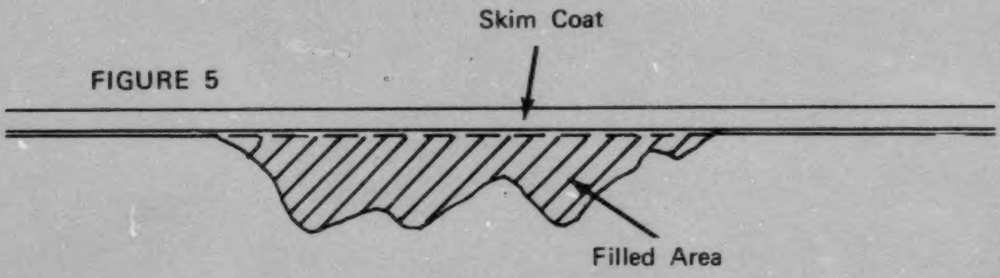


FIGURE 4

(NOTE: Body filler must be worked as soon as it has set. After it has completely cured, a grinder or board file would be necessary resulting in lost time and refilling probably would be necessary.)

E. Skim coat (Figure 5)

FIGURE 5



   1. Apply a thin coat of plastic filler over total filed area

   2. Fill any imperfections in the surface

      Example: File marks, pits, small dents, and other imperfections

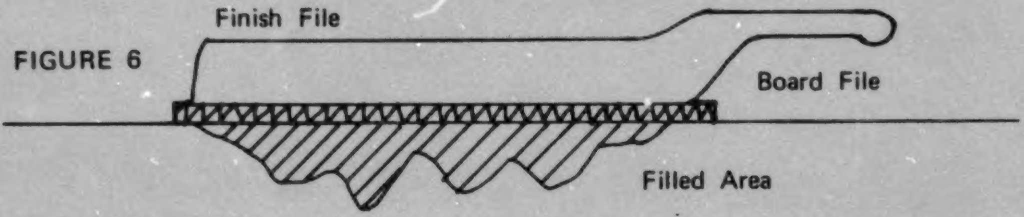
F. Finish file

   1. Allow body plastic filler to cure

JOB SHEET #3

2. File plastic filler with hand files (Figure 6)

FIGURE 6



   a. File with coarse grit sandpaper

   b. Finish file with fine grit sandpaper

(NOTE: If during the filing procedure metal appears through the body filler, stop filing. Either the surface is high or the plastic filler is low or level. Continued filing will result in refilling the entire panel.)

(NOTE: Pneumatic files are available for filing plastic. Basic skill must be acquired before using these tools.)

BODY FILLING
UNIT V

JOB SHEET #4--SURFACE PREPARATION FOR SOLDER FILLING

I. Tools, equipment, and materials

   A. Body grinder

   B. Drill 1/4"

   C. Carbon brush or wire brush

   D. Oxyacetylene torch

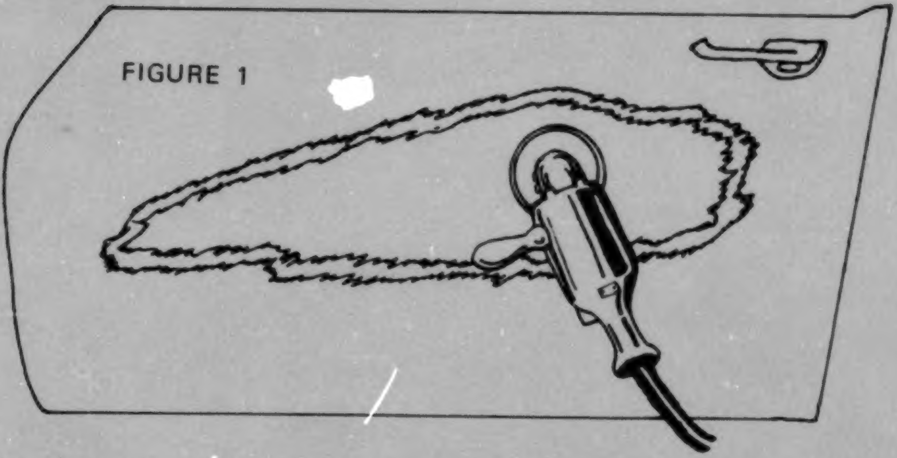
   E. Tinning flux or acid core solder

   F. Body solder

II. Procedure

   A. Grind surface (Figure 1)

FIGURE 1



      1. Remove all paint, oil, or weld scale from surface

      2. Clean surface to a bright metal finish

      3. Clean at least two inches around area to be filled

JOB SHEET #4

B. Tin area (Figure 2)

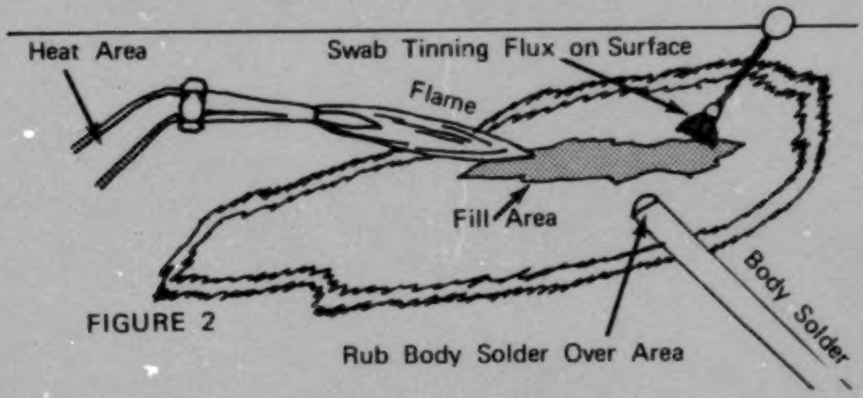

Heat Area
Swab Tinning Flux on Surface
Flame
Fill Area
Body Solder
Rub Body Solder Over Area

FIGURE 2

1. Swab tinning flux over the area to be filled

   (NOTE: Flux should extend past area to be filled.)

   (NOTE: When using powdered flux or acid core solder, follow directions on containers for each.)

2. Heat area

   (NOTE: Expand surface to prevent distortion during solder filling.)

3. Apply solder for tinning

   a. Continue heating surface

   b. Rub body solder over area

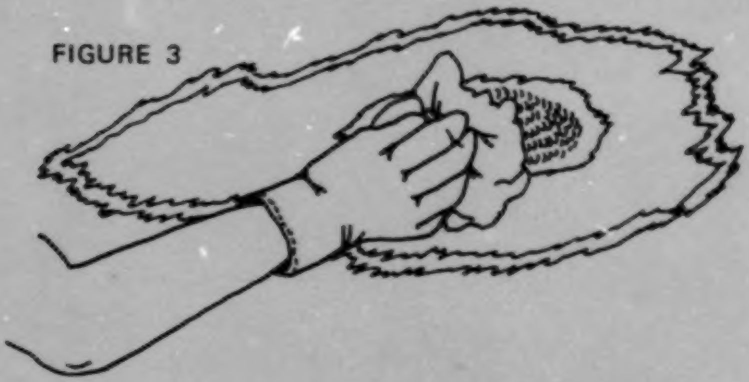
   (NOTE: Some body men prefer acid core solder.)

   (NOTE: It is not necessary to cover total area with solder.)

JOB SHEET #4

4. Wipe solder (Figure 3)

FIGURE 3



a. Continue to play heat over area

b. Wipe molten solder over the area using a clean cloth

    1) Wipe in only one direction

    2) Wipe over total area lightly

BODY FILLING
UNIT V

JOB SHEET #5--APPLICATION OF BODY SOLDER

I. Tools, equipment, and materials

   A. Soldering paddles and kit

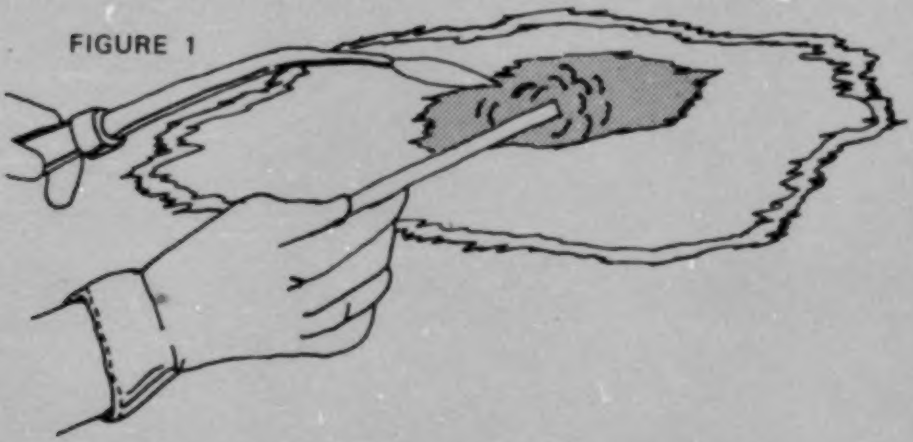
   B. Oxyacetylene torch

   C. Body solder

II. Procedure

   A. Apply body solder (Figure 1)

FIGURE 1

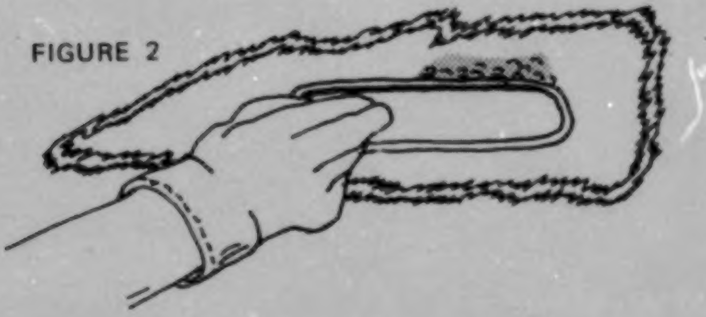


1. Heat surface until tinning begins to melt
2. Heat 1 or 2 inches of the bar solder until it reaches plastic state
3. Press soft end of bar onto surface and twist to break off the soft end of solder bar

JOB SHEET #5

B. Paddle, smooth, and level (Figure 2)

FIGURE 2



1. Repeat A-3 building the proper fill and contour

   (NOTE: Smooth and shape each new deposit of body solder into the previous deposit. Prolonged heating and paddling will result in porous fills and a build area slightly higher than base.)

2. Build area slightly higher than base

   (NOTE: Be sure you have applied enough solder to the surface to smooth to proper levels and contours.)

BODY FILLING
UNIT V

JOB SHEET #6--SOLDER FINISHING

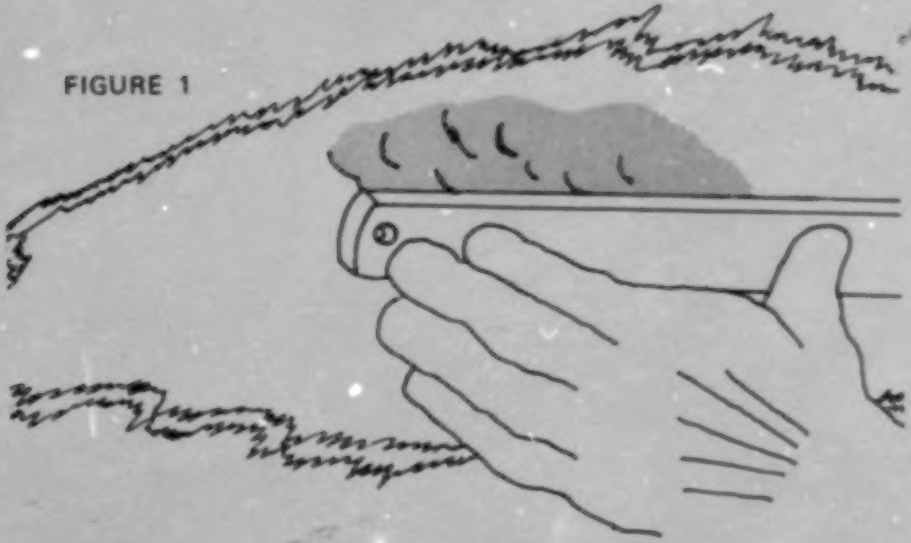
I. Tools, equipment, and materials

- A. Body file--Flat, half round, reveal
- B. Grinder
- C. Open coat disc
- D. Sandpaper

II. Procedure

- A. File surface (Figure 1)

FIGURE 1



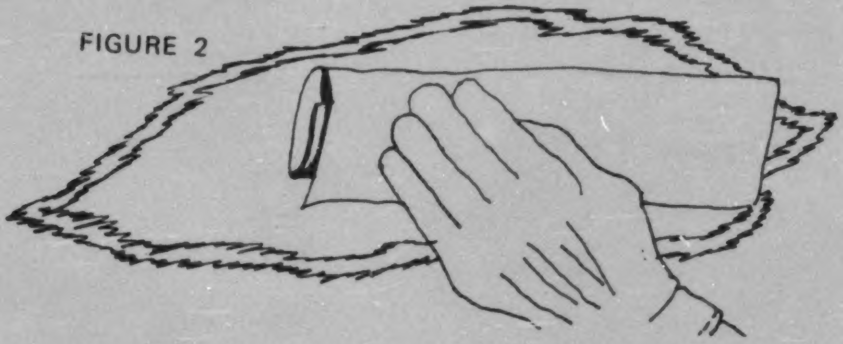
1. Use long continuous strokes
2. Do not cut below proper contour

   (NOTE: Solder is soft and can be cut away quickly making it lower than the surrounding surfaces.)

JOB SHEET #6

B. Sand the solder (Figure 2)

FIGURE 2



1. Sand to remove file or grinder marks
2. Use a file to support paper to prevent digging out low spots on the surface; a board file could be used

(NOTE: Unlike body plastic, after the solder has cooled it can be raised or lowered with a pick hammer, if necessary, without damage.)

BODY FILLING
UNIT V

TEST

1. Match the following terms associated with body filling to the list of definitions provided.

_____a. A step in soldering required to let the solder adhere to the metal

_____b. A pot used to keep molten body solder in a large quantity during a large filling operation

_____c. Amount necessary to build the surface being filled to the proper level

_____d. Usually a pigmented cream catalyst which causes the plastic filler to harden; it also causes the color to change when it is properly mixed

_____e. Small holes in applied body filler due to improper mixing and too much hardener

_____f. Mixing action to properly blend hardener with plastic filler

_____g. Usually a polyester resin to which various fibers and other materials have been added; used to fill dents in automotive body sheet metal

_____h. Air trapped in body filler when mixing due to improper stirring; as a result, affected plastic filler must be removed and refilled

_____i. An acid used to clean the sheet metal during the tinning procedure

1. Plastic filler
2. Hardener
3. Metal preparation
4. Kneading
5. Cheese grater
6. Pin holes
7. Build up
8. Body solder
9. Flux
10. Tinning
11. Mush pot
12. Air pocket

______j. Step in which all impurities must be removed from surface (paint, slag, rust, or others) before body filler or solder can be used

______k. Name given to the "Stanley Shurform File" used by body men to rough file body filler

______l. A lead-tin combination used to fill dents and joints in automobile bodies

2. List seven steps in applying plastic solder.

a.

b.

c.

d.

e.

f.

g.

3. List the four basic steps in applying body solder.

a.

b.

c.

d.

4. List the three materials that under normal conditions will be on the surface to be soldered and must be removed.

a.

b.

c.

5. Write the four steps in tinning.

a.

b.

c.

d.

6. Demonstrate the ability to:

   a. Prepare the surface for plastic filler.

   b. Mix plastic filler.

   c. Apply and finish plastic body filler.

   d. Prepare the surface for solder filler.

   e. Apply body solder.

   f. Finish file solder filler.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

BODY FILLING
UNIT V

ANSWERS TO TEST

1. a. 10
   b. 11
   c. 7
   d. 2
   e. 6
   f. 4
   g. 1
   h. 12
   i. 9
   j. 3
   k. 5
   l. 8
2. a. Clean the surface
   b. Mix plastic filler
   c. Apply a "tin" coat of filler
   d. Fill and build
   e. Rough file
   f. Skim coat
   g. Finish
3. a. Clean the surface
   b. Tinning
   c. Filling and shaping
   d. Metal finishing

4.
    a. Paint
    b. Weld scale
    c. Rust
5.
    a. Clean the surface
    b. Apply flux
    c. Heat surface and apply solder
    d. Heat area until solder melts and wipe surface with a clean cloth
6. Performance skills will be evaluated according to the criteria listed on the progress chart.

Auto Body

PROGRESS CHART

Section F-1
Basic Metal Repair

	Unit I Surface Preparation -- Metal Repair				Unit II Roughout															
	1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Job	Unit Test	Clean an Exterior Surface	Clean an Interior Surface		Unit Test	Align a Hood	Align a Fender	Align a Headlight Assembly	Align a Bumper	Align a Door	Align a Deck Lid	Align a Taillight Assembly	Align Moldings & Trim	Roughout a Single and/or Combination Crowned Panel	Roughout a Low Crowned Panel	Roughout a Double High Crowned Panel	Roughout a Reversed Crown Panel	Roughout a Flange or Bead		
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
85% Correct																		
To Satisfaction of Instructor																		
To Satisfaction of Instructor																		
85% Correct																		
See Manufacturer's Specifications																		
See Manufacturer's Specifications																		
See Manufacturer's Specifications																		
See Manufacturer's Specifications																		
See Manufacturer's Specifications																		
See Manufacturer's Specifications																		
See Manufacturer's Specifications																		
Within 1/8" of Original Contour of Panel & Aligned with Adjacent Panels																		
Within 1/8" of Original Contour of Panel & Aligned with Adjacent Panels.																		
Within 1/8" of Original Contour of Panel & Aligned with Adjacent Panels.																		
Within 1/8" of Original Contour of Panel & Aligned with Adjacent Panels.																		
Within 1/8" of Original Contour of Panel & Aligned with Adjacent Panels.																		

Auto Body

PROGRESS CHART

Section F-2
Basic Metal Repair (continued)

	Unit III Metal Finishing								Unit IV Shrinking						Unit V Body Filling						
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	1	2	3	4	5	6	7
			Grind, Pick & File																		
Job	Unit Test	Remove Paint from Damaged Area by Buffing	Flat Panel	High Crown Panel	Reverse Crown Panel	Concave Groove	Finish Buff		Unit Test	Hot Shrink Raised Metal	Hot Shrink Gouged Metal	Cold Shrink with Slapping Spoon	Cold Shrink with a Shrinking Hammer & Dolly		Unit Test	Prepare Surface for Plastic Filler	Mix Plastic Filler	Apply & Finish Plastic Filler	Prepare Surface for Solder Filler	Apply Body Solder	Finish File Solder Filler
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4
85% Correct																	
Until Low Areas are Exposed																	
Restore to Original Contour																	
Restore to Original Contour																	
Restore to Original Contour																	
Restore to Original Contour																	
Remove all Fill & Buffer Marks																	
85% Correct																	
Until Restored to Original Contour																	
Until Restored to Original Contour																	
Until Restored to Original Contour																	
Until Restored to Original Contour																	
85% Correct																	
All Paint and Foreign Matter Removed																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
All Paint & Foreign Matter Removed																	
Sufficient to Finish to Original Contour																	
Until Restored to Original Contour																	

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to identify the types of molding and trim fasteners. He should be able to remove and replace the various types of moldings and trim. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify the types of molding and trim fasteners.
2. Demonstrate the ability to:
    a. Remove and replace belt molding.
    b. Remove and replace rocker molding.
    c. Remove and replace wheel opening molding.
    d. Remove and replace reveal molding.
    e. Remove and replace drip rail scalp molding.
    f. Remove and replace script nameplate trim.

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency masters

    1. TM 1--Fastening Devices

    2. TM 2--Fastening Devices (Continued)

    3. TM 3--Fastening Devices (Continued)

4. TM 4--Fastening Devices (Continued)

D. Job sheets

1. Job Sheet #1--Remove and Replace Belt Molding
2. Job Sheet #2--Remove and Replace Rocker Molding
3. Job Sheet #3--Remove and Replace Wheel Opening Molding
4. Job Sheet #4--Remove and Replace Reveal Molding
5. Job Sheet #5--Remove and Replace Drip Rail Scalp Molding
6. Job Sheet #6--Remove and Replace Script Nameplate Trim

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques*. First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Co., 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

C. MacPherson, Robert C. *Collision Repair Guide*. New York: McGraw-Hill Inc., 1971.

D. Spicer, Edward D. *Automotive Collision Repair Guide*. Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Toboldt, Bill. *Auto Body Repair and Refinishing*. South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

F. Tait, A., A. G. Deroche, and N. N. Hildebrand. *The Principles of Auto Body Repairing and Repainting*. Englewood, New Jersey: Prentice-Hall Inc., 1971.

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

INFORMATION SHEET

I. Common types of molding and trim fasteners (Transparencies 1, 2, 3, and 4)

   A. Spring clip

   B. Screw attached molding

   C. Nut attached molding with stud

   D. Reveal clip (stud or screw type)

   E. Weld on stud

   F. T bolt or spring bolt clip

   G. Bathtub clip

   H. W base clip

   I. Bayonet clip

   J. Scalp molding

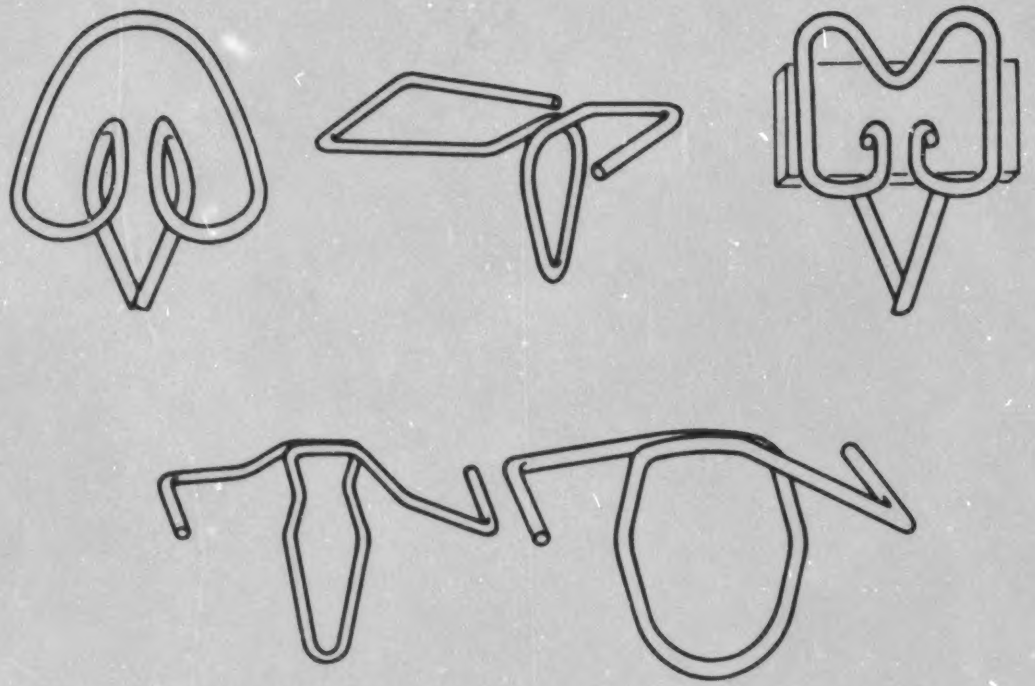
   K. Pinchweld clip

   L. Joint clip

   M. Stud

   N. Threaded stud clip

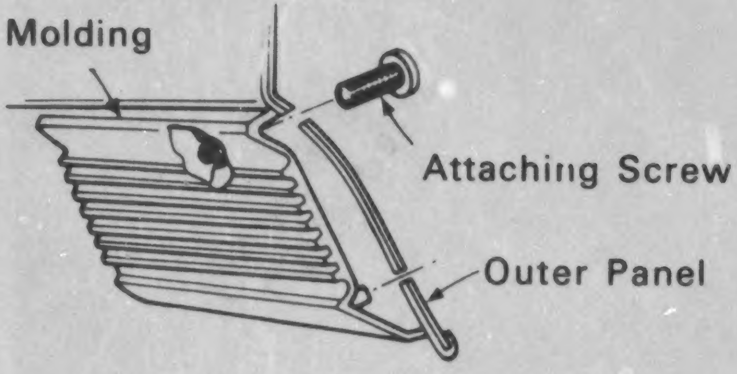
Fastening Devices



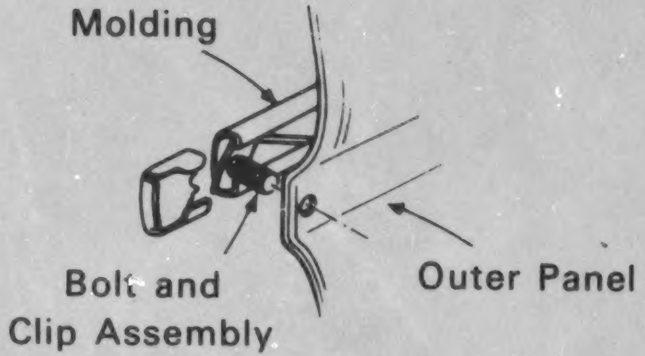
SPRING CLIPS

Fastening Devices

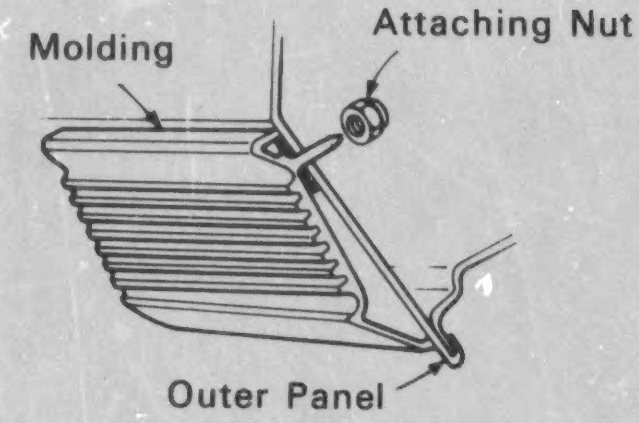
(CONTINUED)


Molding
Attaching Screw
Outer Panel

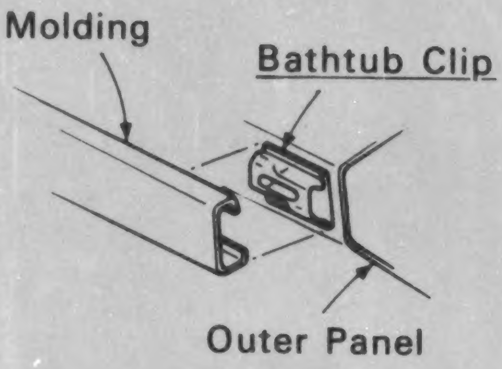
Screw Attached Molding


Molding
Outer Panel
Bolt and
Clip Assembly

T Bolt or Spring Bolt Clip

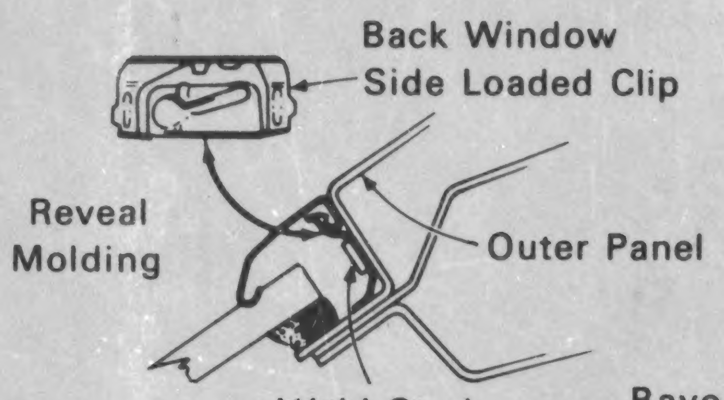

Molding
Attaching Nut
Outer Panel

Nut Attached Molding with T Stud

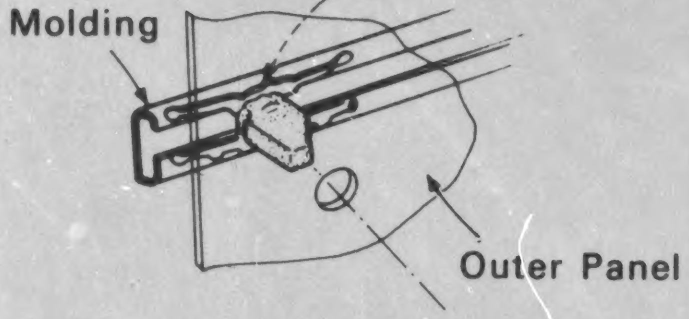

Molding
Outer Panel

Bathtub Clip

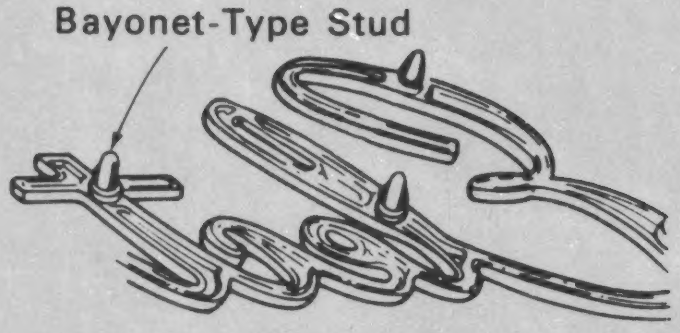
Fastening Devices
(CONTINUED)


Back Window
Side Loaded Clip
Reveal
Molding
Outer Panel
Weld Stud

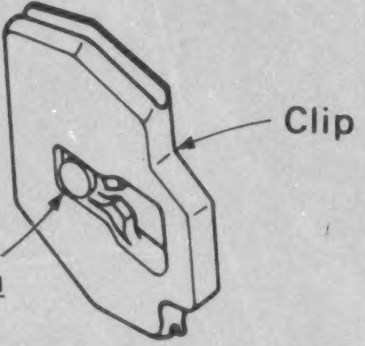
Reveal Clip


Molding
Outer Panel

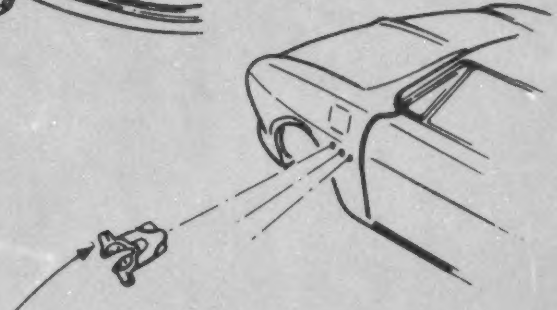
W Base Clip


Bayonet-Type Stud

Stud



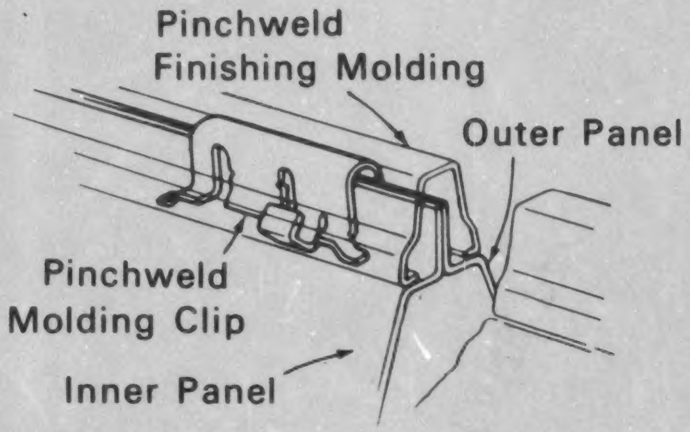
Weld on
Stud



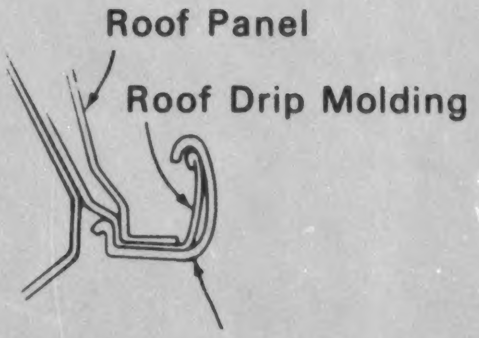
Bayonet Clip

Fastening Devices

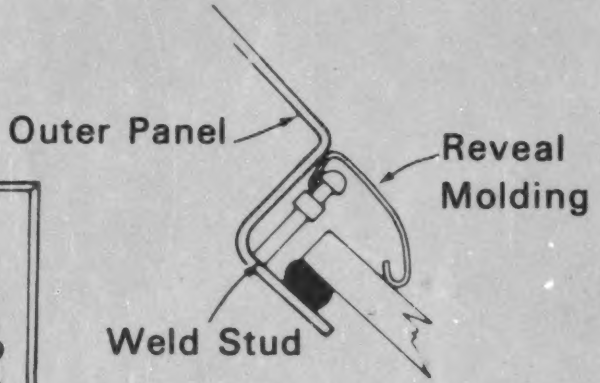
(CONTINUED)

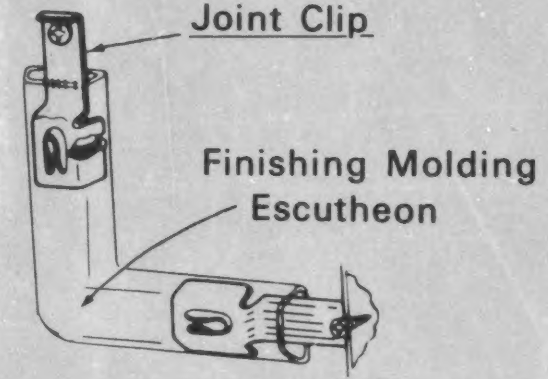

Pinchweld
Finishing Molding
Outer Panel
Pinchweld
Molding Clip
Inner Panel

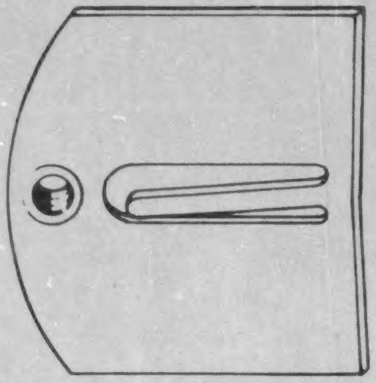
Pinchweld Clip


Roof Panel
Roof Drip Molding

Scalp Molding


Outer Panel
Reveal
Molding
Weld Stud


Joint Clip
Finishing Molding
Escutheon



Threaded Stud Clip

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

JOB SHEET #1--REMOVE AND REPLACE BELT MOLDING

I. Tools and equipment needed

  A. Phillips screwdriver set

  B. Straight blade screwdriver

  C. 1/4" drive ratchet and socket set

  D. 5/16"-9/16" end wrenches

II. Procedure

  A. Examine molding

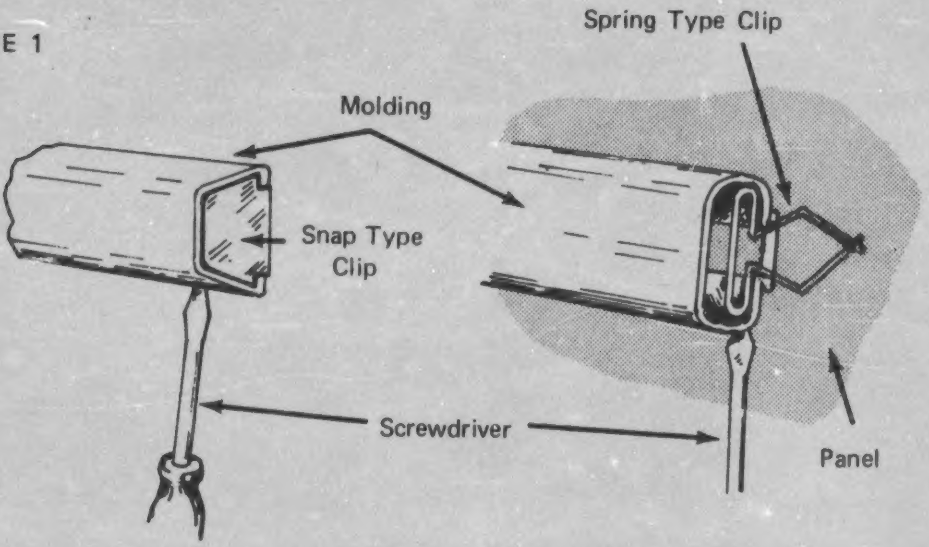
    1. Determine the location of bolt or screw attaching clips

    2. Determine type of snap on clip

    (NOTE: At the end of each molding, there is usually a screw or nut attaching clip. Remove this clip before attempting the removal of the molding.)

  B. Pry molding off of snap type clip or pry spring type clip from retaining hole (Figure 1)

FIGURE 1



JOB SHEET #1

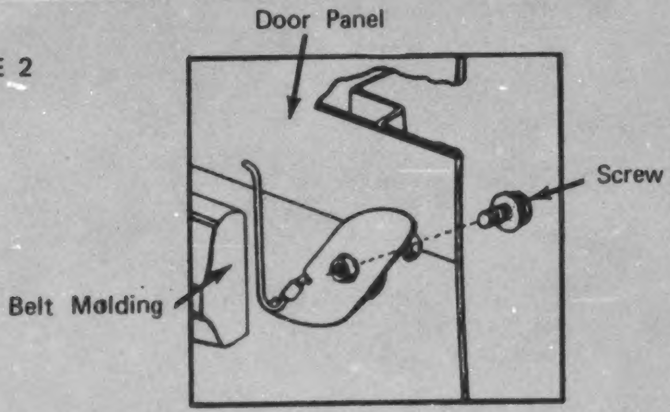
(IMPORTANT: Always pry molding off at the clip to prevent damage to the molding. Do not damage paint surface. If scratched, it must be touched up to prevent rust.)

C. Replace damaged clips

D. Snap new molding in place

E. Replace screw or nut at the ends of moldings (Figure 2)

FIGURE 2



(NOTE: Always be sure door moldings will clear fenders and other adjoining panels. Some vehicles use an adhesive to attach molding. Remove this carefully with a putty knife. Reinstall by using a special adhesive or use a new molding.)

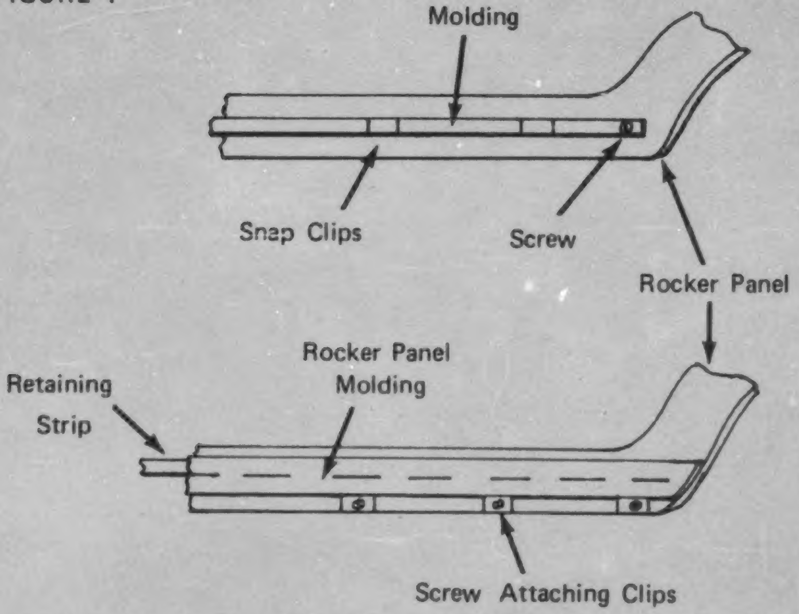
EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

JOB SHEET #2--REMOVE AND REPLACE ROCKER MOLDING

I. Tools and equipment needed
  A. Phillips screwdriver (No. 1 and 2 blade)
  B. Straight blade screwdriver
  C. 1/4" drive ratchet and socket set
  D. 5/16"-9/16" end wrenches

II. Procedure
  A. Determine how molding is attached
    1. Screws
    2. Clips
  B. Remove all retaining screws (Figure 1)

FIGURE 1


Molding
Snap Clips
Screw
Rocker Panel
Retaining Strip
Rocker Panel Molding
Screw Attaching Clips

JOB SHEET #2

C. Remove rocker panel molding

D. Replace rocker panel molding

    1. Replace all damaged clips

    2. Snap molding over clips or slide behind retaining clip

    3. Replace all screws

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

JOB SHEET #3--REMOVE AND REPLACE WHEEL OPENING MOLDING

I. Tools and equipment needed

  A. Phillips screwdriver set

  B. Straight blade screwdriver

  C. 1/4" ratchet and socket set

  D. 5/16"-9/16" end wrench set

II. Procedure

  A. Determine how wheel opening molding is attached

    1. Screw attached

    2. T bolt attached

  B. Remove molding

    1. Remove all screws

    2. Remove all T bolts

    (NOTE: On some models using T bolts, the inner fender must be removed to gain access to T bolt nuts.)

  C. Replace molding

  (NOTE: To replace molding, follow step B in reverse.)

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

JOB SHEET #4--REMOVE AND REPLACE REVEAL MOLDING

I. Tools and equipment needed

   A. Phillips screwdriver (No. 1 and 2 blade)

   B. Straight blade screwdriver

   C. 1/4" drive rachet set

   D. 1/4"-9/16" end wrenches

   E. Reveal molding clip tool

II. Procedure

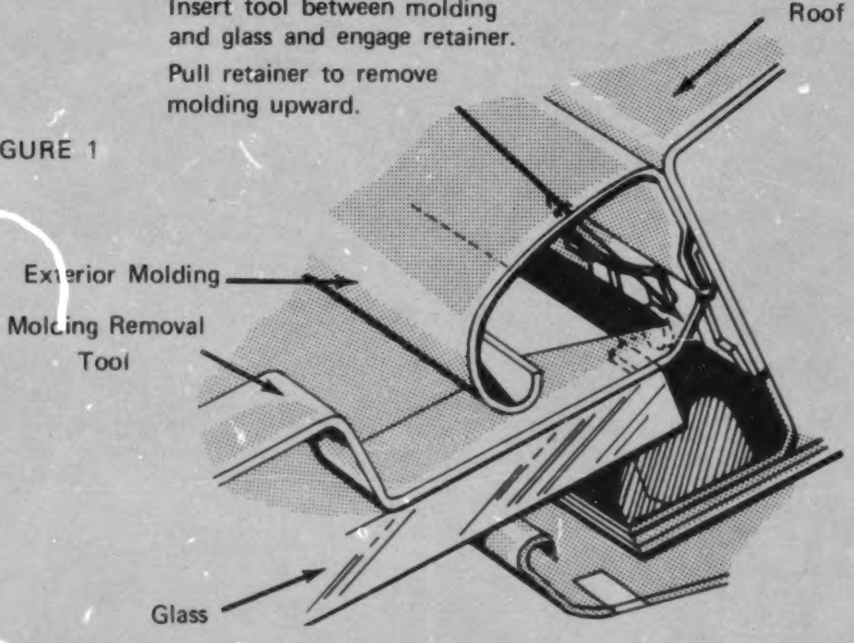
   A. Determine how reveal molding is attached

   B. Remove molding

      1. Remove all screws

      2. Remove all T bolts

      3. Remove molding using reveal molding clip tool to release clips (Figure 1)


Insert tool between molding and glass and engage retainer.

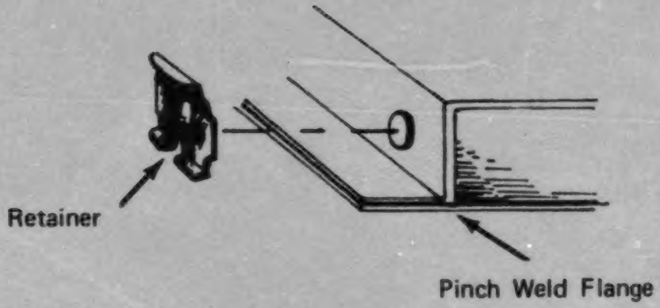
Pull retainer to remove molding upward.

FIGURE 1

JOB SHEET #4

C. Replace all damaged clips (Figure 2)

FIGURE 2



D. Replace molding

1. Snap molding in place

   (NOTE: Use hand only. Reveal moldings are easily bent or dented.)

2. Replace screws and T bolts nuts

   (NOTE: Reveal molding around door glass and side glass is usually snap clip or T bolt attached. Examine carefully.)

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

JOB SHEET #5--REMOVE AND REPLACE DRIP RAIL SCALP MOLDING

I. Tools and equipment needed

   A. Straight blade screwdriver

   B. Phillips screwdriver set

   C. Soft rubber mallet

II. Procedure

   A. Determine how drip molding is attached

      1. Screws

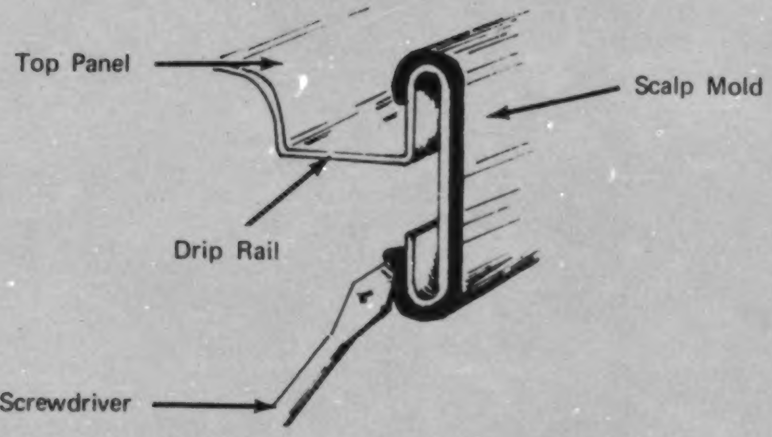
      2. Snap over drip rail (true scalp molding)

   B. Remove drip molding

      1. Remove screws and remove moldings if screw attached

      2. Carefully pry off edge of drip molding if scalp attached (Figure 1)

FIGURE 1



JOB SHEET #5

(NOTE: If scalp molding is to be reused, it must be removed very carefully. Because it is held by its own spring tension, it can easily be sprung.)

C. Replace drip rail molding

1. Screw type

   a. Caulk

   b. Reinstall screws

2. Scalp type snap over drip rail

   (NOTE: Scalp molding may need to be tapped lightly with a rubber mallet. If necessary, tap on the top edge lightly.)

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

JOB SHEET #6--REMOVE AND REPLACE SCRIPT NAMEPLATE TRIM

I. Tools and equipment needed

A. Straight blade screwdriver

B. Phillips screwdriver set

C. 1/4" drive ratchet and socket set

II. Procedure

A. Determine how nameplate trim is attached

1. Screw

2. Nut

3. Bayonet clip

B. Remove nameplate

1. Remove screw and nameplate or

2. Remove nut and nameplate

(NOTE: On nut attached nameplates, it may be necessary to loosen panel to gain access to back side to remove nuts.)

3. Pry bayonet clip attached nameplate off panel

C. Replace nameplate

1. Replace screws in nameplate or

2. Replace nuts on nameplate or

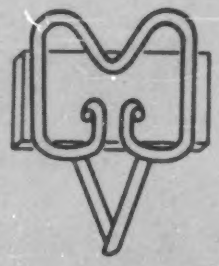
3. Push nameplate in place on bayonet clips

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

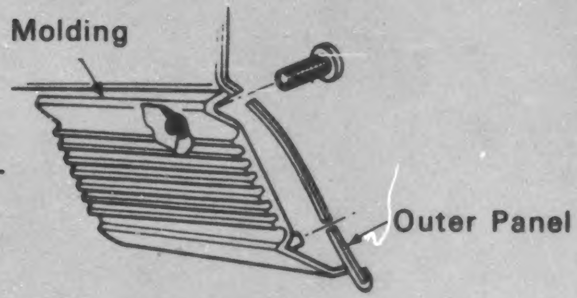
TEST

1. Identify the types of molding and trim fasteners.

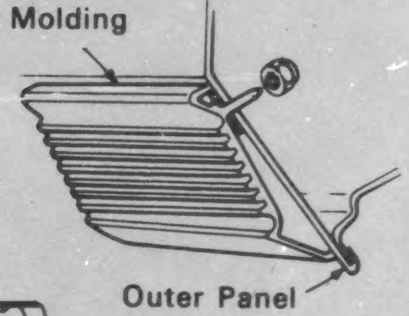
a. ______________________



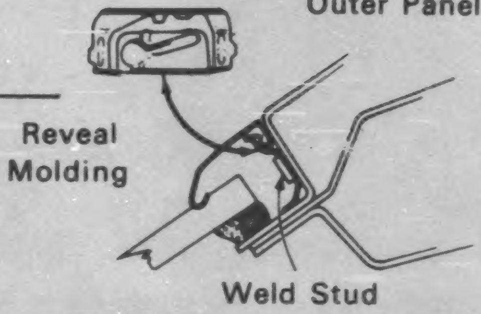
b. ______________________


Molding
Outer Panel

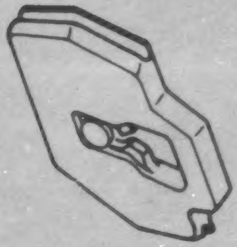
c. ______________________


Molding
Outer Panel

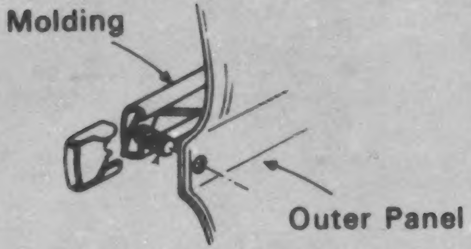
d. ______________________


Reveal Molding
Weld Stud

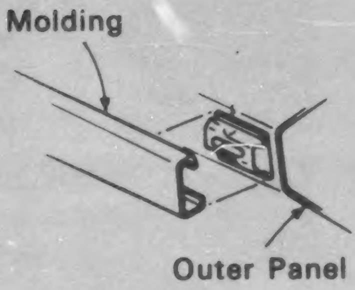
e.________________________



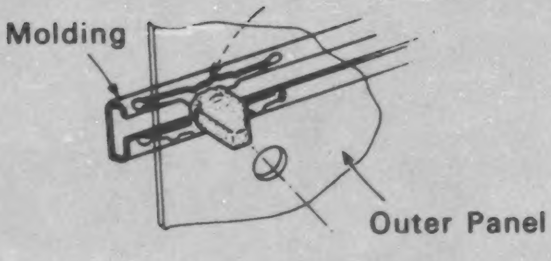
f.________________________


Molding
Outer Panel

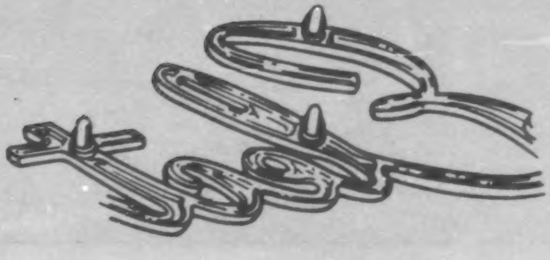
g.________________________


Molding
Outer Panel

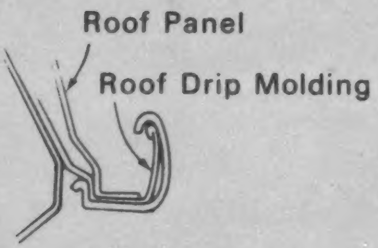
h.________________________


Molding
Outer Panel

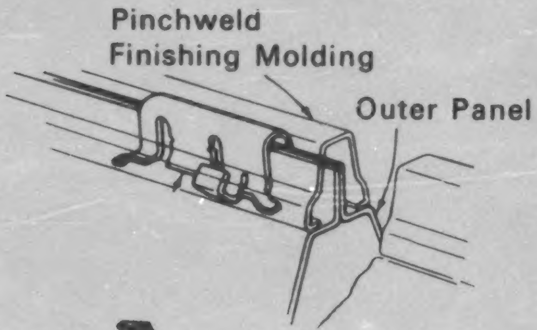
i.________________________



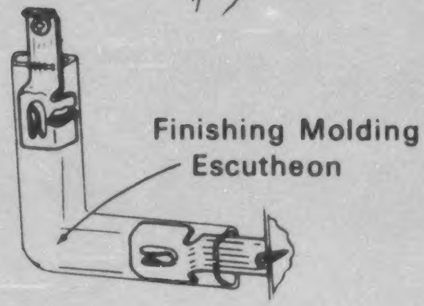
j. ____________________


Roof Panel
Roof Drip Molding

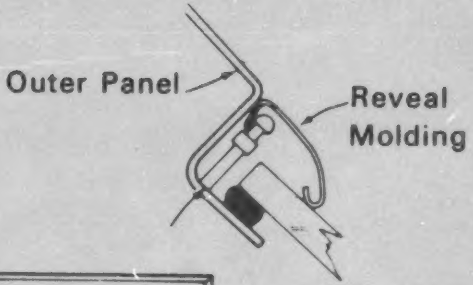
k. ____________________


Pinchweld Finishing Molding
Outer Panel

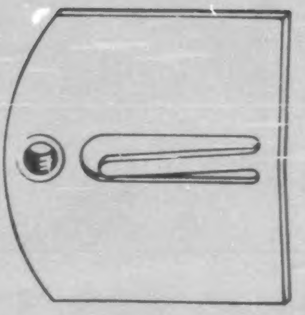
l. ____________________


Finishing Molding Escutheon

m. ____________________


Outer Panel
Reveal Molding

n. ____________________



2. Demonstate the ability to:

   a. Remove and replace belt molding.

   b. Remove and replace rocker molding.

   c. Remove and replace wheel opening molding.

   d. Remove and replace reveal molding.

   e. Remove and replace drip rail scalp molding.

   f. Remove and replace script nameplate trim.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

EXTERIOR MOLDING AND TRIM FASTENERS
UNIT I

ANSWERS TO TEST

1. a. Spring clip
   b. Screw attached molding
   c. Nut attached molding with stud
   d. Reveal clip
   e. Weld on stud
   f. T bolt or spring bolt clip
   g. Bathtub clip
   h. W base clip
   i. Bayonet clip
   j. Scalp molding
   k. Pinchweld clip
   l. Joint clip
   m. Stud
   n. Threaded stud clip

2. Performance skills will be evaluated according to the criteria listed on the progress chart.

INTERIOR TRIM
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms and definitions associated with interior trim, identify inside door handle mountings, and match interior hardware and trim to illustrations. He should be able to remove and replace inside door handles, door trim panels, seats, and drop and install a headliner. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match a list of terms associated with interior trim to the correct definition.
2. Identify the three common inside door and handle mounting methods.
3. Match interior hardware and trim to illustrations.
4. Choose from a list two methods for fastening headliners to the top of the automobile.
5. Demonstrate the ability to:
    a. Remove and replace a clip attached door handle.
    b. Remove and replace a screw attached door handle.
    c. Remove and replace a pin attached door handle.
    d. Remove and replace a door trim panel.
    e. Remove and replace seats.
    f. Drop and install a headliner.

INTERIOR TRIM
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Discuss terminal and specific objectives.

   D. Discuss information sheet.

   E. Demonstrate and discuss procedures outlined in job sheets.

   F. Give test.

II. Students:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheet.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Job sheets

      1. Job Sheet #1--Remove and Replace a Clip Attached Door Handle

      2. Job Sheet #2--Remove and Replace a Screw Attached Door Handle

      3. Job Sheet #3--Remove and Replace a Pin Attached Door Handle

      4. Job Sheet #4--Remove and Replace a Door Trim Panel

    5. Job Sheet #5--Remove and Replace Seats

    6. Job Sheet #6--Drop and Install a Headliner

  D. Test

  E. Answers to test

II. References:

  A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Co., 1969.

  B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

  C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

  D. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

  E. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

  F. Tait, A., A. G. Deroche, and N. N. Hildebrand. *The Principles of Auto Body Repair and Repainting.* Englewood Cliffs, New Jersey: Prentice-Hall., Inc., 1971.

INTERIOR TRIM
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Armrest--That part of the door trim panel upon which the arm of the driver or passenger can rest

B. Cushion--The bottom part of the front or rear seat

C. Backrest--The back part of the front or rear seat

D. Door handle--Interior handle for opening the door

E. Kick pad--Part of the car interior that fits between the front door opening and the cowl on both the left and right sides under the dash panel

F. Step plate--Metal panel that covers the edge of the floor mat in the door opening

G. Garnish molding--Any trim molding that fits around the windshield, back glass, or door glass

H. Clothes hanger--Piece of trim molding that fastens to the side roof rails that allows clothes to be hung in a vehicle

I. Interior light--Dome light or any interior light used to illuminate the interior

J. Trim panel--Any interior panel, usually vinyl or cloth that is used to cover interior panels

K. Floor mat--The floor covering, usually carpet or rubber

L. Rear parcel shelf--Shelf behind the rear seat backrest at the rear glass

M. Wind cord--Interior cord used to seal the crack between the doors and the door openings

N. Center pillar trim--Trim used to cover the center pillar (post)

O. Window handles--Handles used to raise and lower windows

P. Sun visor--Covered panel which can be lowered to protect passenger's eyes from sunlight at the windshield area

Q. Headliner--Cloth, vinyl, or interior board which covers underneath the roof to protect the passengers from undercoating and to act as a sound deadener

INFORMATION SHEET

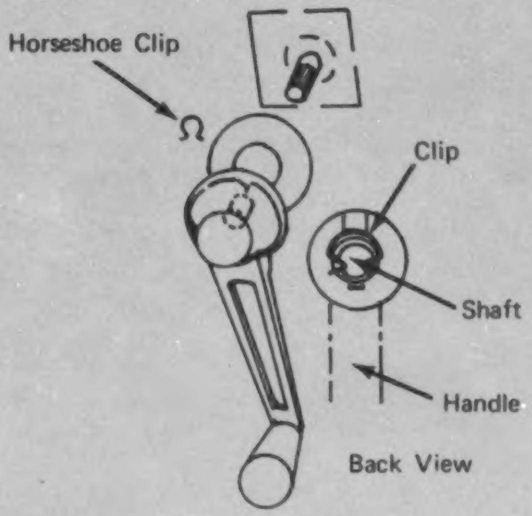
II. Common inside door handle mounting methods

   A. Clip attached

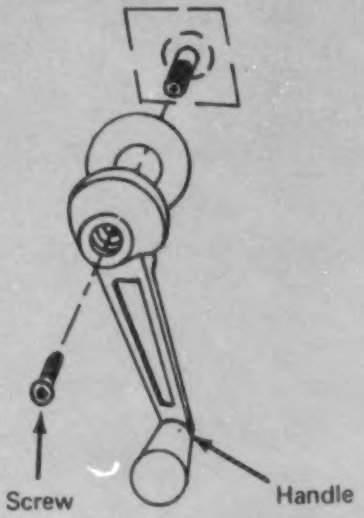
   B. Screw attached

   C. Pin attached

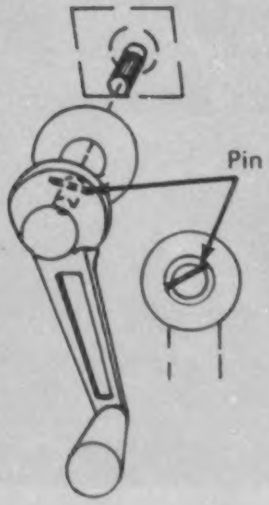
Horseshoe-Clip Attachment


Horseshoe Clip
Clip
Shaft
Handle
Back View

Screw Attachment

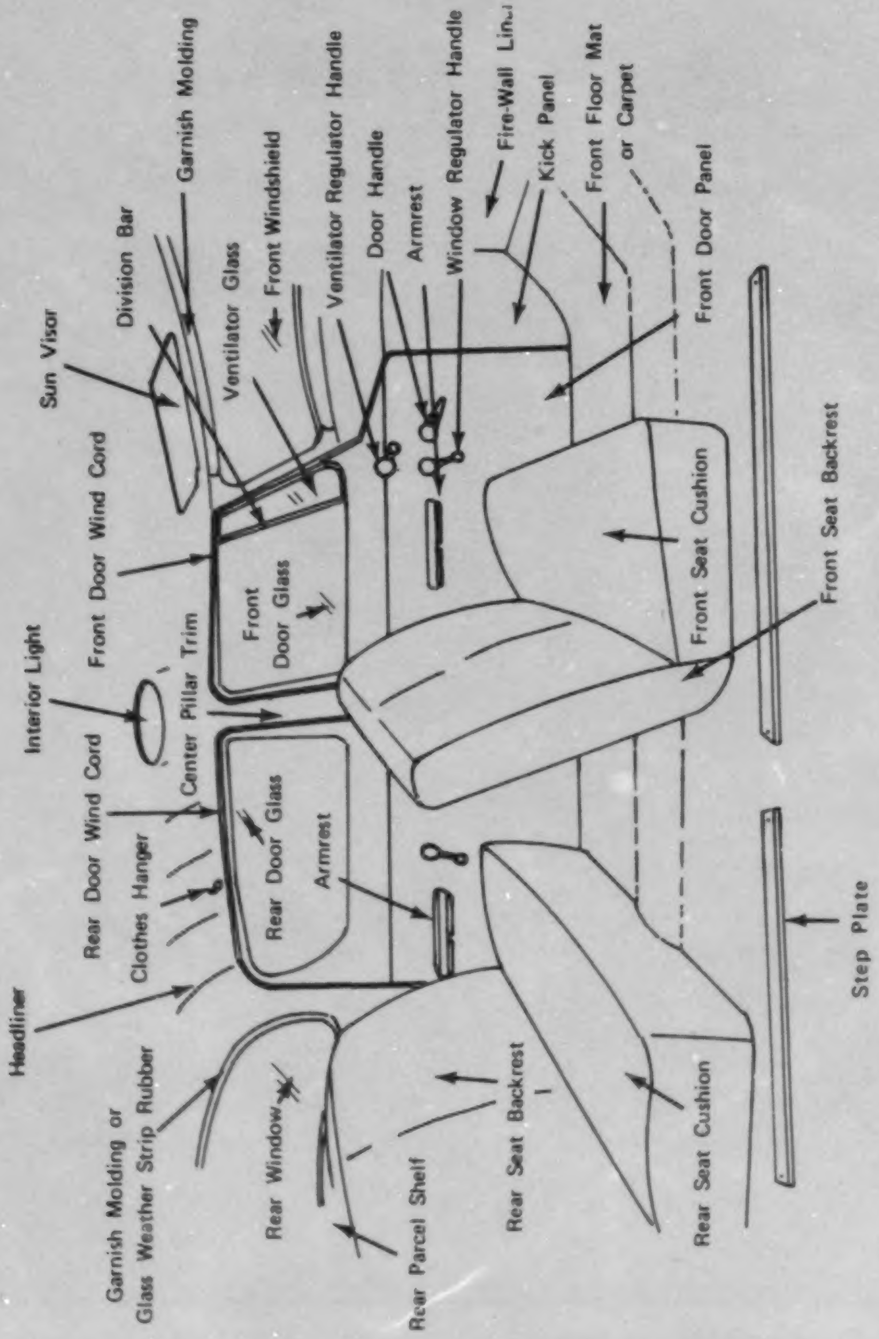

Screw
Handle

Pin Attachment



INFORMATION SHEET

III. Interior hardware and trim


Garnish Molding
Division Bar
Sun Visor
Front Windshield
Ventilator Glass
Ventilator Regulator Handle
Door Handle
Armrest
Window Regulator Handle
Fire-Wall Lin.
Kick Panel
Front Floor Mat or Carpet
Front Door Panel
Front Door Wind Cord
Front Door Glass
Front Seat Cushion
Front Seat Backrest
Interior Light
Center Pillar Trim
Rear Door Wind Cord
Rear Door Glass
Armrest
Clothes Hanger
Headliner
Step Plate
Garnish Molding or Glass Weather Strip Rubber
Rear Window
Rear Parcel Shelf
Rear Seat Backrest
Rear Seat Cushion

INFORMATION SHEET

IV. Methods for fastening headliners to the top of the automobile

   A. Listing wire to side roof rail

   B. Headliner fastened between pronged retainer and roof rail

   C. Headliner retained behind header by tension strips

      (NOTE: This method is used on foreign cars.)

   D. Headliner retained by tack strips and covered by moldings and trim strips

INTERIOR TRIM
UNIT II

JOB SHEET #1--REMOVE AND REPLACE A CLIP ATTACHED DOOR HANDLE

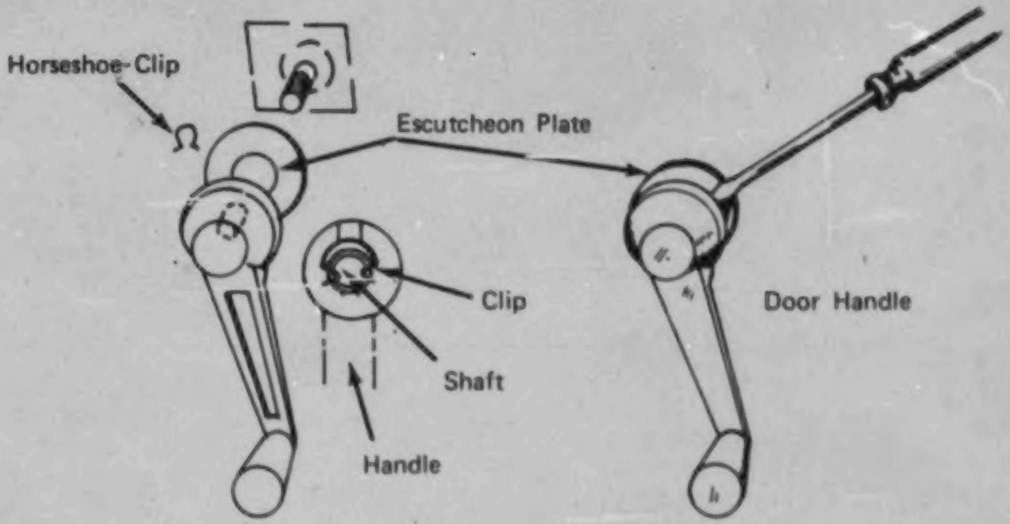
I. Tools and equipment needed

- A. Straight blade screwdriver
- B. Door handle pliers
- C. Door handle clip removal tool

II. Procedure

- A. Insert screwdriver between interior handle or window roller handle and escutcheon plate to locate clip (Figure 1)

FIGURE 1

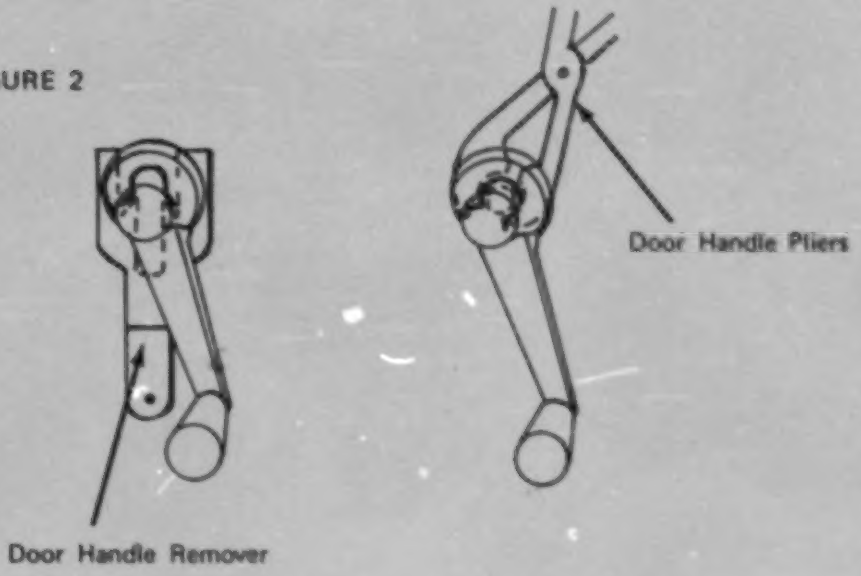

Horseshoe-Clip
Escutcheon Plate
Clip
Door Handle
Shaft
Handle

HORSESHOE-CLIP ATTACHMENT

B. Remove clip (Figure 2)

(NOTE: Be careful not to insert tool between escutcheon plate and trim panel. Trim panel could be damaged during clip removal if tools come into contact with cloth or vinyl.)

FIGURE 2



C. Remove handle

D. Install clip on handle

E. Install handle

   1. Place escutcheon plate over regulator or remote control shaft

   2. Push handle on shaft

      (NOTE: Work handle several times to be sure it is properly seated.)

      (IMPORTANT: When working with interior trim, always keep hands clean, keep tools on floorboards and off of seats, and do not put tools in your pockets because you may tear seats or other parts of the interior when sitting in car.)

INTERIOR TRIM
UNIT II

JOB SHEET #2--REMOVE AND REPLACE A SCREW ATTACHED DOOR HANDLE

I. Tools and equipment needed

   A. Hex wrench set

   B. Phillips screwdriver

   C. Straight blade screwdriver

II. Procedure (Figure 1)

   A. Remove screw from handle

   B. Remove handle

   C. Remove escutcheon plate

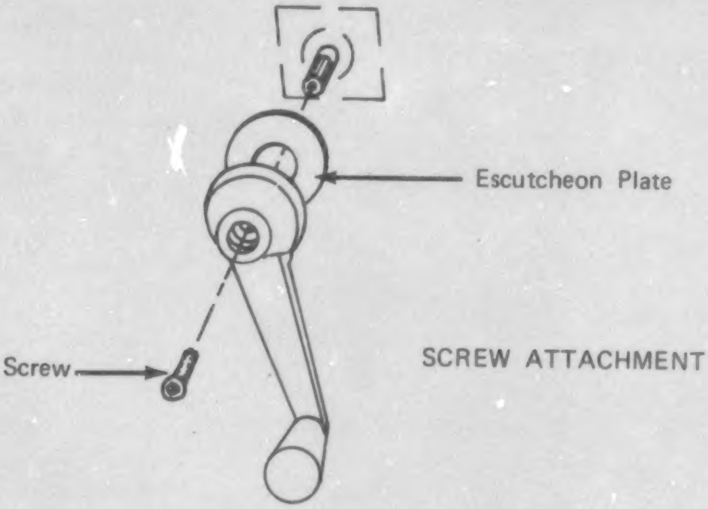
   D. Replace escutcheon plate

   E. Replace handle

   (NOTE: Put handle in same position as when removed.)

   F. Replace screw

FIGURE 1



(NOTE: When working with interior trim, always keep hands clean, keep tools on floorboards and off of seats,and do not put tools in pockets because you may tear seats or other parts of the interior when sitting in vehicle.)

INTERIOR TRIM
UNIT II

JOB SHEET #3--REMOVE AND REPLACE A PIN ATTACHED DOOR HANDLE

I. Tools and equipment needed

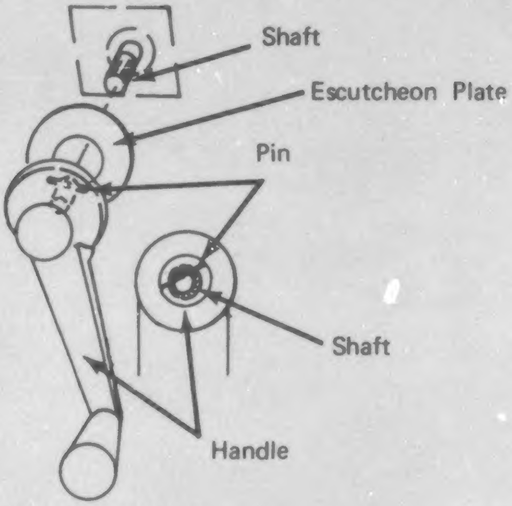
A. Straight blade screwdriver

B. Awl

II. Procedure

A. Locate pin between escutcheon plate and handle (Figure 1)

FIGURE 1



PIN ATTACHMENT

B. Push pin out of handle with awl

(NOTE: Always be careful not to damage trim panel with tools.)

(CAUTION: Never push toward your hand or body with awl. Injury to yourself could occur.)

JOB SHEET #3

C. Remove handle from car

D. Replace handle

1. Start pin in handle
2. Put escutcheon plate on shaft
3. Put handle on shaft and push into position
4. Set pin using screwdriver
5. Work handle several times to be sure that it works properly

   (NOTE: When working with interior trim, always keep hands clean, keep tools on floorboards and off of seats, and do not put tools in pockets because you may tear seats or other parts of the interior when sitting in car.)

[redacted]

INTERIOR TRIM
UNIT II

JOB SHEET #4--REMOVE AND REPLACE A DOOR TRIM PANEL

I. Tools and equipment needed

  A. Door handle removal tools

  B. Door panel removal tools

  C. Straight blade screwdriver

  D. Phillips screwdriver

  E. Hex wrench set

II. Procedure

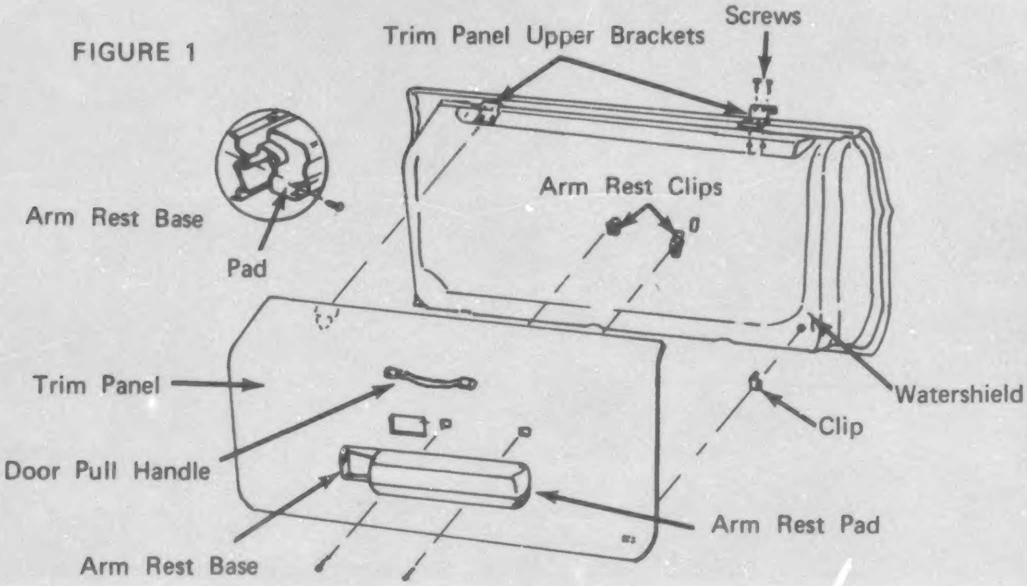
  A. Remove door handles (See Job Sheets 1, 2, and 3.)

  B. Remove arm rest

  C. Remove door pull handle (Figure 1)

  (NOTE: At the end of the door pull handle is usually a screw. Some handles have a chrome or vinyl cap over the ends which must be removed to gain access to the screws.)

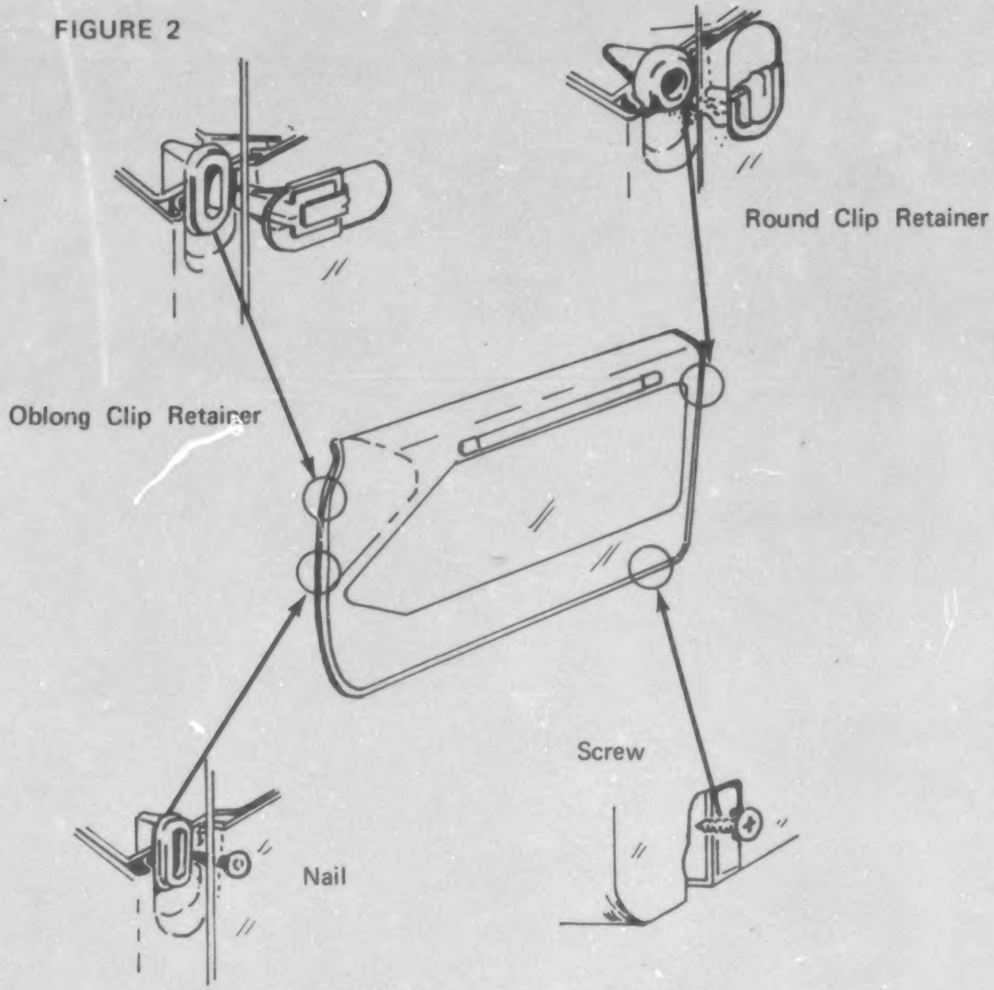
FIGURE 1


Screws
Trim Panel Upper Brackets
Arm Rest Clips
Arm Rest Base
Pad
Trim Panel
Door Pull Handle
Watershield
Clip
Arm Rest Pad
Arm Rest Base

JOB SHEET #4

D. Remove trim panel (Figure 2)

FIGURE 2


Round Clip Retainer
Oblong Clip Retainer
Screw
Nail

Various Types of Door Trim Retention

1. Remove any trim screws
2. Pry trim panel loose from clip retainers

   (NOTE: Be sure not to tear clip from panel or break nails from nail applied panel.)

JOB SHEET #4

E. Remove dust and water seal cover

(NOTE: These covers may be plastic or paper. Remove carefully. It must be replaced to prevent water and dust from getting into the interior of the car.)

F. Replace dust and water cover

1. Glue with an approved adhesive
2. Tape to door inner panel

G. Replace trim panel (Reverse steps A-D)

(NOTE: When working with interior trim, always keep hands clean, keep tools on floorboards and off of seats,and do not put tools in pockets because you may tear seats or other parts of the interior when sitting in vehicle.)

INTERIOR TRIM
UNIT II

JOB SHEET #5--REMOVE AND REPLACE SEATS

I. Tools and equipment needed

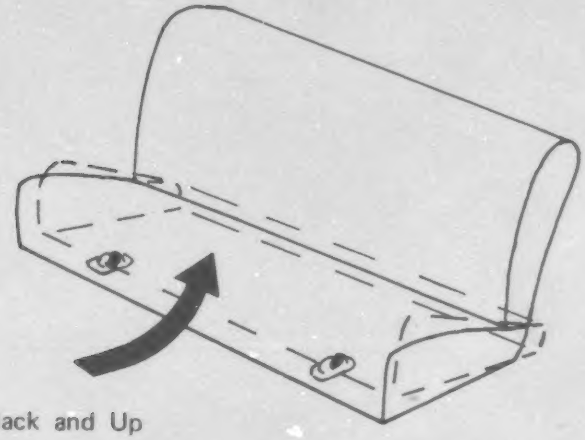
- A. End wrench set
- B. Phillips screwdriver assortment
- C. Straight blade screwdriver assortment
- D. 3/8" drive socket set 5/16"-7/8"
- E. 1/4" drive socket set

II. A. Remove rear seat cushion

(NOTE: Always work with clean hands.)

1. Push back on lower seat cushion (Figure 1)

FIGURE 1



Push Back and Up

2. Remove cushion from car

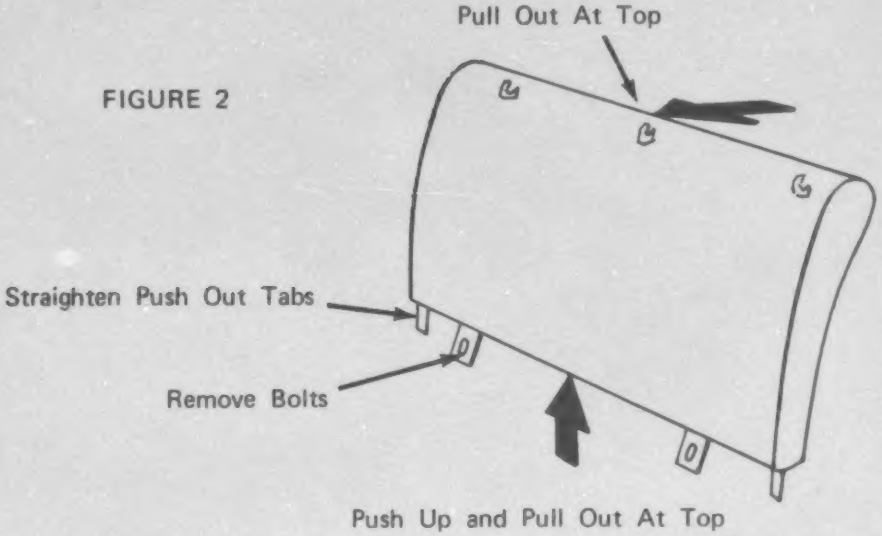
(NOTE: Always store cushions in clean dry area and cover with protective throw covers.)

JOB SHEET #5

3. Remove attaching bolts, nuts, or other fasteners from rear backrest cushion

4. Lift up and pull forward (Figure 2)

FIGURE 2



5. Remove cushion from vehicle

6. Replace rear seat cushions (Reverse steps 1-5)

B. Remove front seat cushion

   1. Remove bolts from seat tracks to floorboard

      (NOTE: Some models use studs which are welded to the floor and are removed from interior under front seat cushion. Other models have bolts which are removed from underneath the floorboard.)

      (CAUTION: If car has to be jacked up, use safety stands.)

   2. Remove seat belt bolts from floorboard

   3. Remove front seat

      (NOTE: Because front seat is heavy, always have someone to help lift the seat out of the car. Do not chance damage to floor mats or injury to yourself.)

JOB SHEET #5

4. Replace front seat (Reverse steps 1-3)

   (NOTE: When working with interior trim, always keep hands clean, keep tools on floorboards and off of seats, and do not put tools in pockets because you may damage or tear seats or other parts of the interior when sitting in vehicle.)

INTERIOR TRIM
UNIT II

JOB SHEET #6--DROP AND INSTALL A HEADLINER

I. Tools and equipment needed

- A. Straight blade screwdriver set
- B. Phillips screwdriver set
- C. 3/8" drive ratchet set
- D. 1/4" drive ratchet set
- E. 5/16"-7/8" end wrench set

II. Procedure

A. Cover all interior

1. Seats
2. Dash
3. Parcel shelf

(NOTE: Headliners are usually dusty and fiber glass insulation is used for sound deadener. Droppings will embed in seats and other trim area creating a dirty condition which is almost impossible to clean up.)

B. Remove hardware and trim

1. Front and rear garnish moldings
2. Rear view mirror
3. Sun visors
4. Courtesy lamps
5. Coat and luggage hooks
6. Moldings along roof rail
7. Shoulder strap anchor plates

JOB SHEET #6

C. Remove all tacks or staples from around headliner

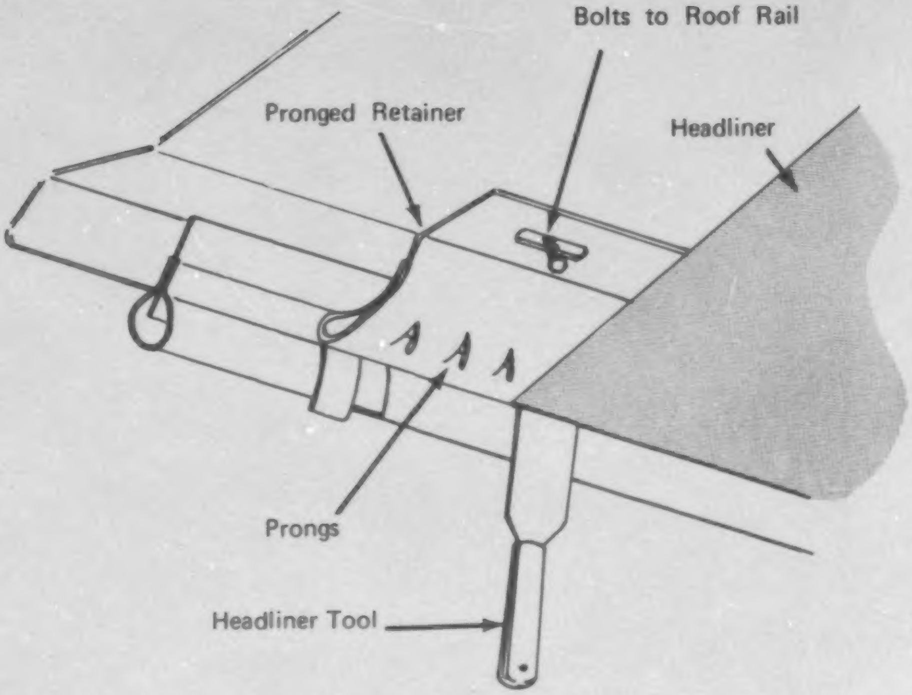
(NOTE: It is very important to remove all fasteners. Headliner could be torn if they are not removed.)

D. Detach headliner at all cemented areas around entire area

E. Drop headliner to first listing rod

(NOTE: Some headliners are attached along the roof rail with a pronged retainer. Release the headliner with a tool which will prevent damage to the liner.) (Figure 1)

FIGURE 1


Bolts to Roof Rail
Pronged Retainer
Headliner
Prongs
Headliner Tool

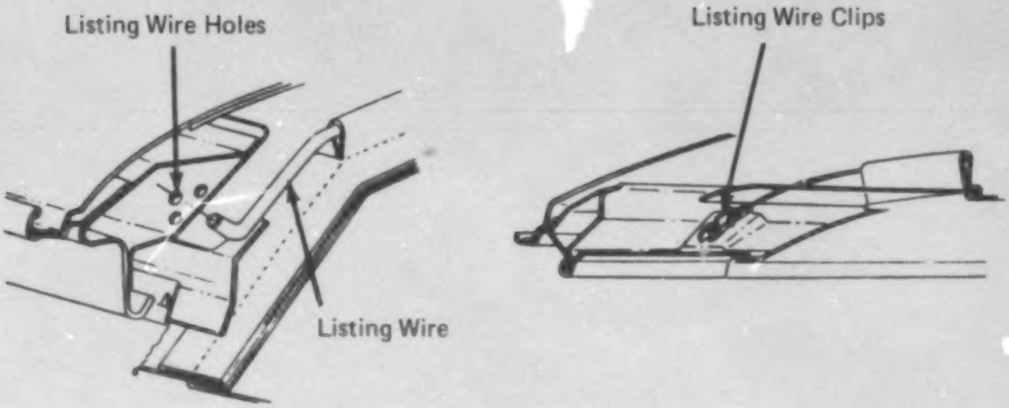
Push up with tool to release headliner from prongs.
Pull headliner out from behind retainer carefully.

JOB SHEET #6

F. Release first listing rod from roof rail

(NOTE: Examine how the listing rod is attached. If fastened with retaining clip or screws, remove. If installed in hole only, push rod toward back of car and remove from hole.) (Figure 2)

FIGURE 2



G. Release balance of listing rods, dropping headliner moving from front to rear of vehicle

(NOTE: Always check each rod carefully to see how it is retained. Rod must be removed without bending.)

H. Remove headliner from vehicle

(NOTE: Fold carefully so outside will not be soiled. Store in clean dry place and cover with protective material to prevent material shrinkage.)

JOB SHEET #6

I. Replace headliner

(NOTE: Keep hands clean at all times.)

1. Attach first listing rod nearest back window to roof rail
2. Attach succeeding rods to roof rail pulling headliner toward front of vehicle as each rod is installed

   (NOTE: Listing rods must be put in same holes or clips as orginally installed.)
3. Attach headliner at rear window
   - a. Tack
   - b. Staple
   - c. Glue

     (NOTE: Use nonstaining glue.)
4. Pull headliner toward front of vehicle working out all wrinkles
5. Fasten headliner to windshield glass area

   (NOTE: Headliner must fit all areas exactly as orginal installation so all molding and trim will fit and not leave obvious marks indicating that headliner was removed.)
6. Fasten headliner to side roof rails
7. Install
   - a. Moldings
   - b. Trim
   - c. Accessories
8. Clean headliner as necessary

   (NOTE: Use method acceptable to each fabric used. Check with your instructor.)

J. Remove protective covers from vehicle

(NOTE: Vehicles today have various type of headliner installations. Always check with shop manual for information on installation to prevent any damage to the headliner during removal. Always keep hands and tools clean to keep from soiling any interior fabrics.)

INTERIOR TRIM
UNIT II

TEST

1. Match the terms on the right with the correct definitions.

_____a. Interior handle for opening the door

_____b. Metal panel that covers the edge of the floor mat in the door opening

_____c. That part of the door trim panel upon which the arm of the driver or passenger can rest

_____d. Shelf behind the rear seat backrest at the rear glass

_____e. Covered panel which can be lowered to protect passenger's eyes from sunlight at the windshield area

_____f. The bottom part of the front or rear seat

_____g. Piece of trim molding that fastens to the side roof rails that allows clothes to be hung in a vehicle

_____h. Interior cord used to seal the crack between the doors and the door openings

_____i. The back part of the front or rear seat

_____j. Dome light or any interior light used to illuminate the interior

1. Garnish molding
2. Rear parcel shelf
3. Armrest
4. Headliner
5. Backrest
6. Cushion
7. Clothes hanger
8. Wind cord
9. Interior light
10. Center pillar trim
11. Sun visor
12. Door handle
13. Window handles
14. Kick pad
15. Floor mat
16. Trim panel
17. Step plate

______k. Handles used to raise and lower windows

______l. Part of the car interior that fits between the front door opening and the cowl on both the left and right sides under the dash panel

______m. Trim used to cover the center pillar (post)

______n. Any trim molding that fits around the windshield, back glass, or door glass

______o. Any interior panel, usually vinyl or cloth that is used to cover interior panels

______p. Cloth, vinyl, or interior board which covers underneath the roof to protect the passengers from undercoating and to act as a sound deadener

______q. The floor covering, usually carpet or rubber

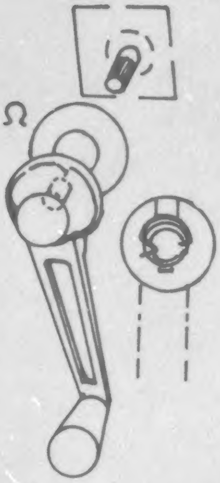
2. Identify the three common inside door and handle mounting methods by placing the correct number in the blanks provided.

_____a. Clip attached

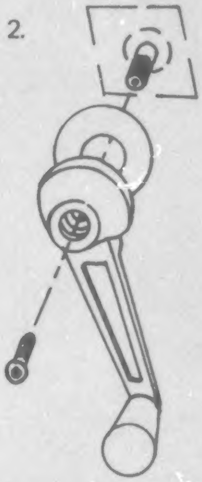
_____b. Pin attached

_____c. Screw attached

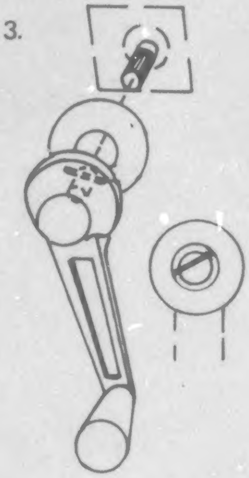
1.



2.



3.



3. Match interior hardware and trim to illustrations by placing the correct number in the blanks provided.

_____a. Clothes hanger

_____b. Front seat backrest

_____c. Front door trim panel

_____d. Fire-wall liner

_____e. Garnish molding

_____f. Armrest

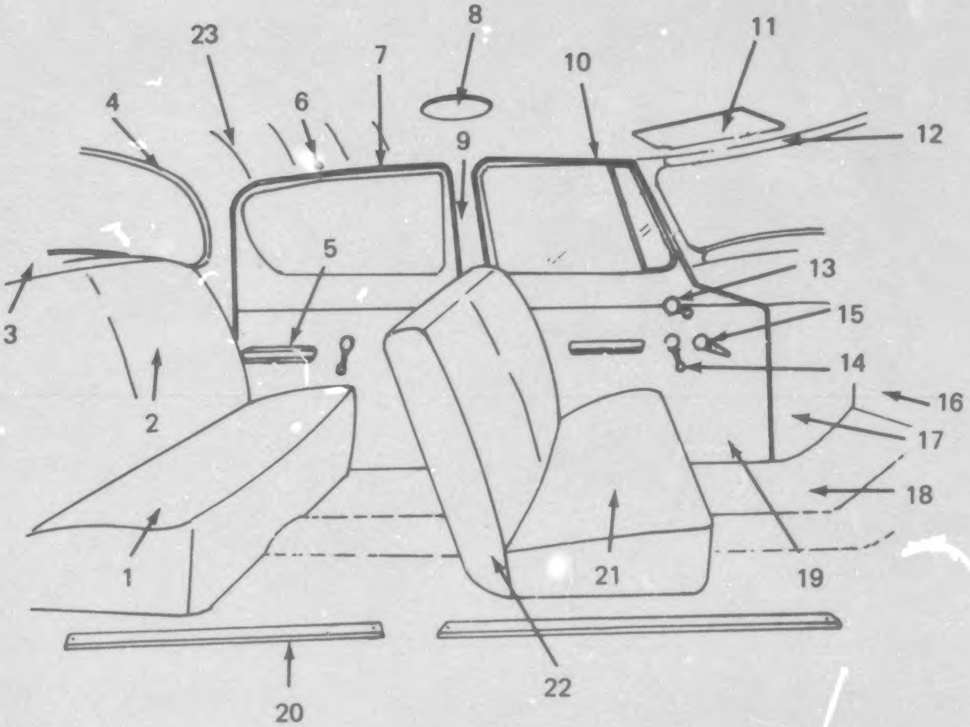
_____g. Rear seat backrest

_____h. Headliner

_____i. Ventilator regulator handle

_____j. Center pillar trim

_____k. Rear seat cushion
_____l. Step plate
_____m. Garnish molding or glass weather strip
_____n. Rear parcel shelf
_____o. Door handle
_____p. Interior light
_____q. Rear door wind cord
_____r. Sun visor
_____s. Window regulator handle
_____t. Floor mat
_____u. Front seat cushion
_____v. Front door wind cord


8
23
7
11
10
4
6
12
9
5
3
2
13
15
14
16
17
18
1
21
19
22
20

4. Choose from a list two methods for fastening headliners to the top of the automobile by circling the correct answers.

    a. Listing wire to center pillar

    b. Listing wire to side roof rail

    c. Headliner glued to pronged retainer

    d. Headliner fastened between pronged retainer and roof rail

    e. Headliner behind roof rail

5. Demonstrate the ability to:

    a. Remove and replace a clip attached door handle.

    b. Remove and replace a screw attached door handle.

    c. Remove and replace a pin attached door handle.

    d. Remove and replace a door trim panel.

    e. Remove and replace seats.

    f. Drop and install a headliner.

    (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

INTERIOR TRIM
UNIT II

ANSWERS TO TEST

1. a. 12
b. 17
c. 3
d. 2
e. 11
f. 6
g. 7
h. 8
i. 5
j. 9
k. 13
l. 14
m. 10
n. 1
o. 16
p. 4
q. 15

2. a. 1
b. 3
c. 2

3. a. 6
b. 22
c. 19
d. 16
e. 12 or 4
f. 5
g. 2
h. 23
i. 13
j. 9
k. 1
l. 20
m. 4 or 12
n. 3
o. 15
p. 8
q. 7
r. 11
s. 14
t. 18
u. 21
v. 10

4. b, d

5. Performance skills will be evaluated according to the criteria listed on the progress chart.

HARDWARE
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms and definitions associated with hardware and match hardware to illustrations. He should be able to remove and replace window regulators, remote controls, lock cylinders, door latches, glass channels, and door weather strips. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with hardware to the correct definition.
2. Identify interior hardware.
3. Identify exterior hardware.
4. Demonstrate the ability to:
    a. Remove and replace a manual window regulator.
    b. Remove and replace an electric window regulator.
    c. Remove and replace a vent window assembly.
    d. Remove and replace an inside door remote control.
    e. Remove and replace a door lock cylinder.
    f. Remove and replace a door latch.
    g. Remove and replace an outside door handle.
    h. Remove and replace a center division channel.
    i. Remove and replace a run channel.
    j. Remove and replace a door weather strip.

HARDWARE
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1--Door Hardware

      2. TM 2--Door Hardware (Continued)

      3. TM 3--Door Hardware (Continued)

D. Job sheets

1. Job Sheet #1--Remove and Replace a Manual Window Regulator
2. Job Sheet #2--Remove and Replace an Electric Window Regulator
3. Job Sheet #3--Remove and Replace a Vent Window Assembly
4. Job Sheet #4--Remove and Replace an Inside Door Remote Control
5. Job Sheet #5--Remove and Replace a Door Lock Cylinder
6. Job Sheet #6--Remove and Replace a Door Latch
7. Job Sheet #7--Remove and Replace an Outside Door Handle
8. Job Sheet #8--Remove and Replace a Center Division Channel
9. Job Sheet #9--Remove and Replace a Run Channel
10. Job Sheet #10--Remove and Replace a Door Weather Strip

E. Test

F. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Co., 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

D. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

F. Tait, A., A. G. Deroche, and N. N. Hildebrand. *The Principles of Auto Body Repairing and Repainting.* Englewood Cliffs, New Jersey: Prentice Hall Inc., 1971.

HARDWARE
UNIT III

INFORMATION SHEET

I. Terms and definitions (Transparency 1)

A. Stabilizer strip--Cushioned strip used to stabilize the window and to prevent rattling when window is lowered

B. Lower sash channel--Channel that is attached to the bottom of any door, quarter, or tailgate glass

C. Guides--Used in place of center division channel and run channel to guide glass up and down

D. Regulator--Gear operated mechanism which lowers and raises the glass

E. Remote control--Any device used to open or lock latches using a system of rods and levers away from the lock

F. Cam--Rollers or slide block which run in channels and guides

G. Lock--Door latch or key lock

H. Door handle--Door inner or outer opener

I. Equalizer arm--Pivot channel which is adjustable to allow for adjustment of glass

(NOTE: If the channel is fixed, then the regulator must be adjustable.)

J. Stop--Upper or lower, used to prevent the glass from rolling out the top or off the bottom guides

II. Interior hardware (Transparencies 1, 2, and 3)

1. Window assembly
2. Stabilizer strips
3. Trim pad adjusting plates
4. Lower sash channel cam
5. Front guide
6. Window regulator
7. Door latch remote control

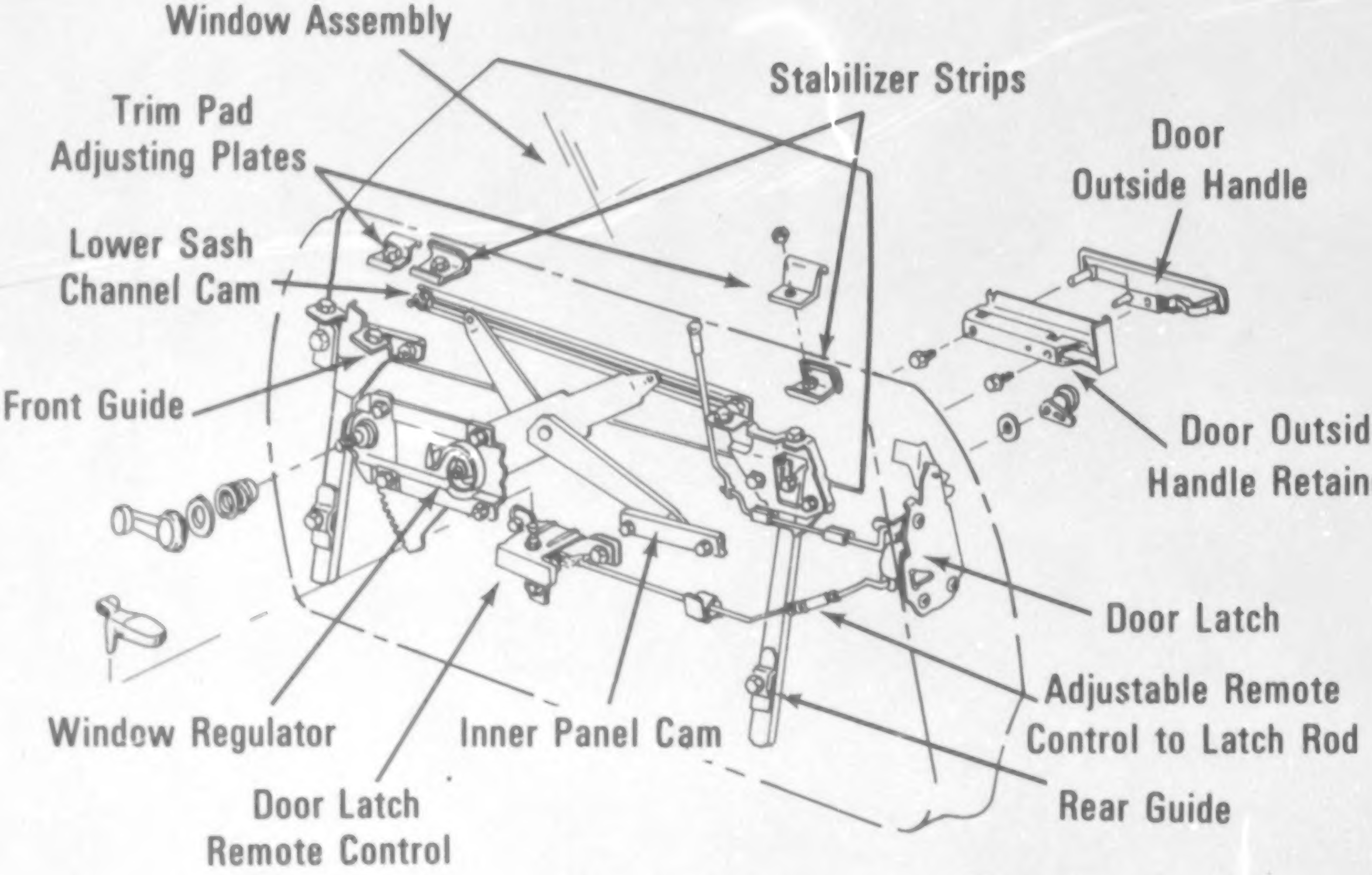
INFORMATION SHEET

8. Inner panel cam
9. Rear guide
10. Adjustable remote control to latch rod
11. Door latch
12. Center division channel
13. Run channel
14. Weather strip

III. Exterior hardware (Transparency 1)

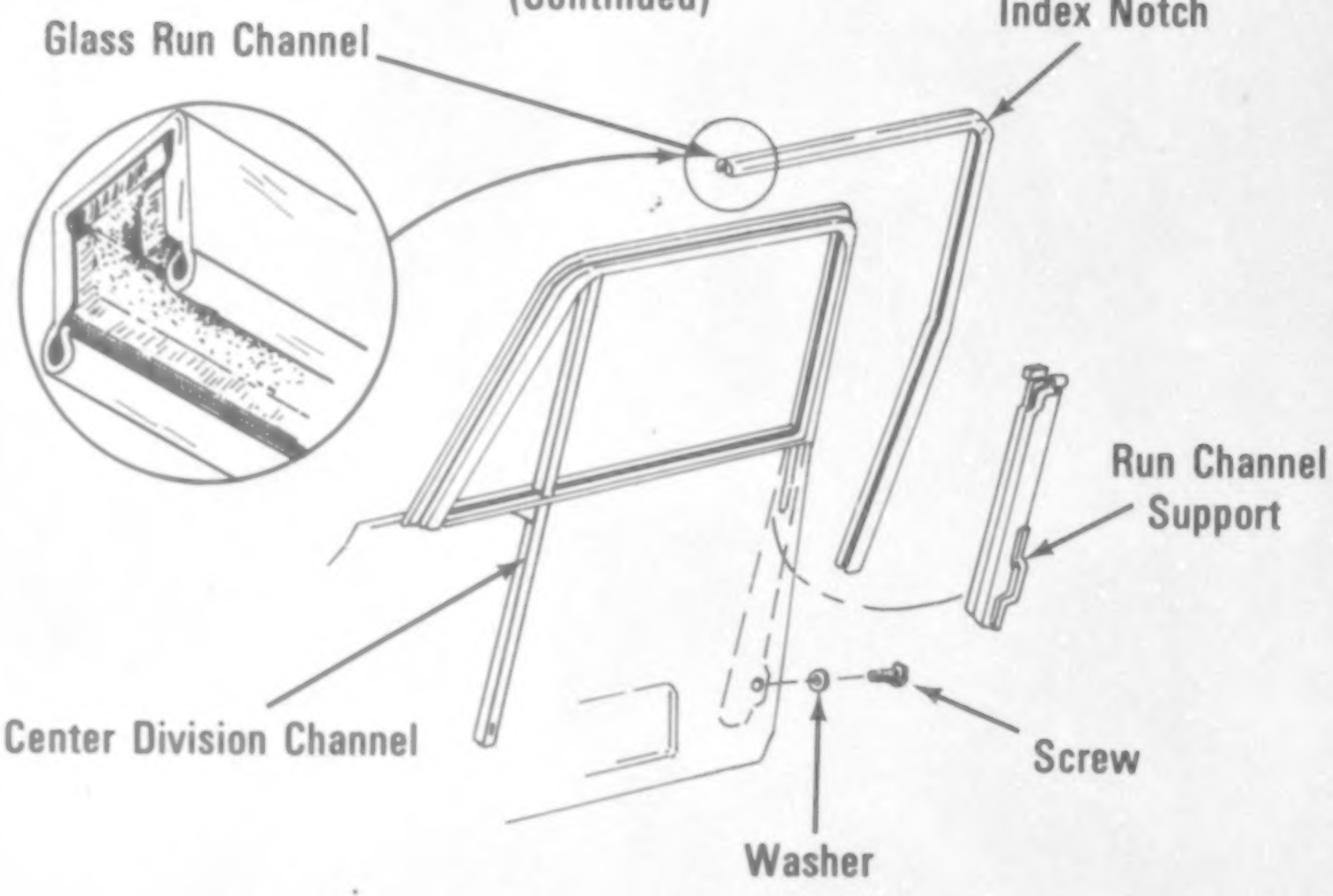
1. Outside door handle
2. Outside key door lock

Door Hardware


Window Assembly
Stabilizer Strips
Trim Pad
Adjusting Plates
Door
Outside Handle
Lower Sash
Channel Cam
Front Guide
Door Outside
Handle Retainer
Door Latch
Adjustable Remote
Control to Latch Rod
Rear Guide
Window Regulator
Inner Panel Cam
Door Latch
Remote Control

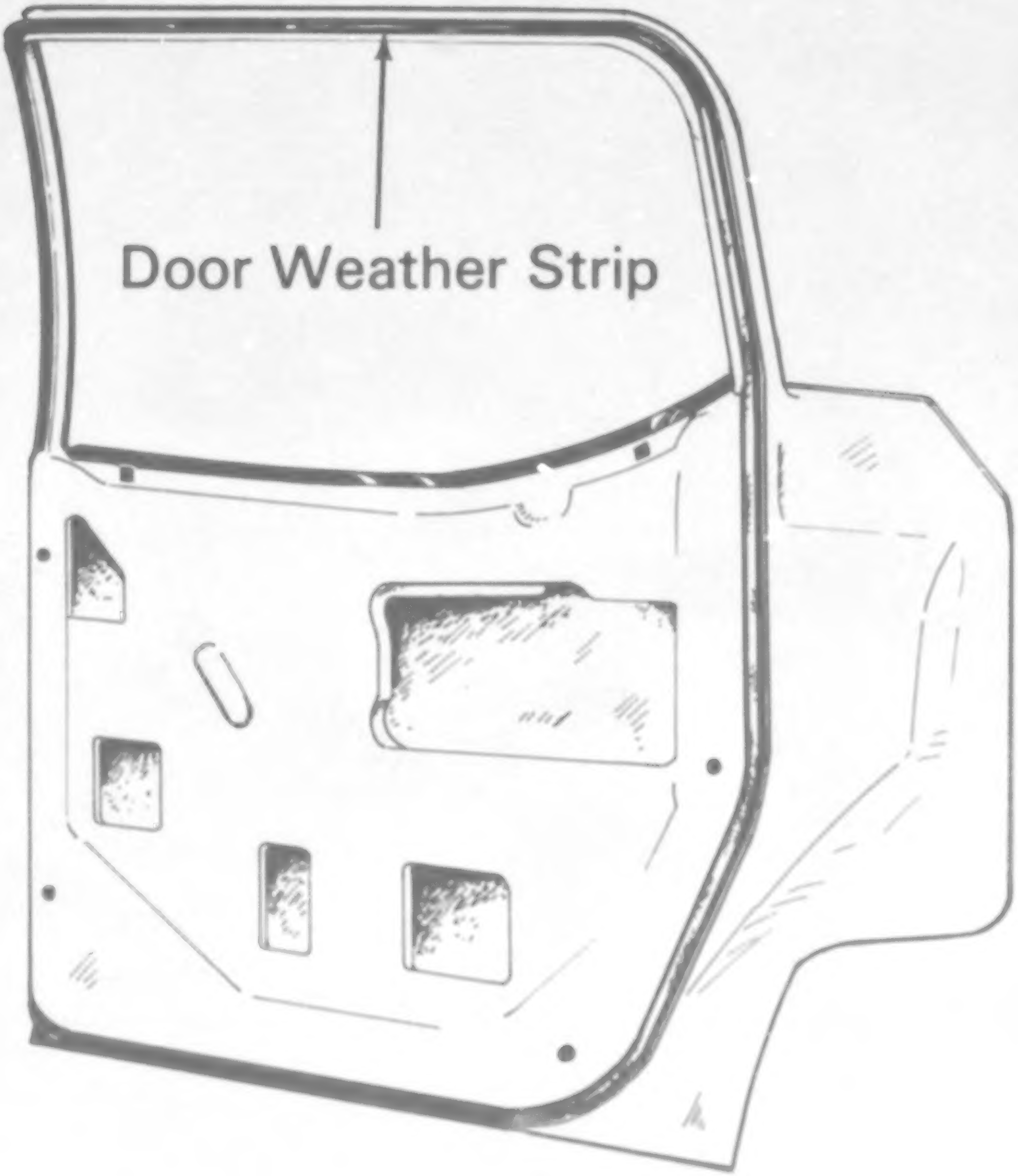
Door Hardware

(Continued)


Glass Run Channel
Index Notch
Run Channel Support
Center Division Channel
Screw
Washer

Door Hardware

(Continued)


Door Weather Strip

HARDWARE
UNIT III

JOB SHEET #1--REMOVE AND REPLACE A MANUAL WINDOW REGULATOR

I. Tools and equipment needed

  A. Wrenches 1/4"-5/8"

  B. Adjustable wrench 10"

  C. 1/4" drive socket set

  D. 3/8" drive socket set

  E. Phillips screwdriver set

  F. Straight blade screwdriver set

  G. Door handle remover tools

  H. Trim pad remover tools

  I. Hex wrench set

  J. Weather strip adhesive

  K. Trim adhesive

  L. Lubricant (oil, grease)

  M. Awl

II. Procedure

  A. Remove door trim panel (See Unit II, Job Sheet #4.)

  B. Remove dust and water seal cover

  C. Remove regulator cam rollers or bolts form sash channel

  (NOTE: It may be necessary to remove door glass. If so, see Unit IV, Job Sheet #2 and #3. If it is not necessary, block glass in the up position so it will be out of the way.)

  D. Remove bolts from regulator

    1. Slide out of pivot channel

JOB SHEET #1

2. Remove through opening in door

   (NOTE: On some makes, the center division channel will have to be removed to allow clearance for the regulator to be removed.)

   (CAUTION: Regulators are spring loaded. Do not allow fingers to get caught in the arms or gear movements.)

E. Replace regulator (Reverse steps A-D)

(NOTE: If window adjustment was not changed, window should work freely. Always check proper alignment and operation of the glass before installing the trim panel.)

HARDWARE
UNIT III

JOB SHEET #2--REMOVE AND REPLACE AN ELECTRIC WINDOW REGULATOR

I. Tools and equipment needed

  A. Wrenches 1/4"-5/8"

  B. Adjustable wrench 10"

  C. 1/4" drive socket set

  D. 3/8" drive socket set

  E. Phillips screwdriver set

  F. Straight blade screwdriver set

  G. Door handle remover tools

  H. Trim pad remover tools

  I. Hex wrench set

  J. Weather strip adhesive

  K. Trim adhesive

  L. Lubricant (oil, grease)

  M. Awl

II. Procedure

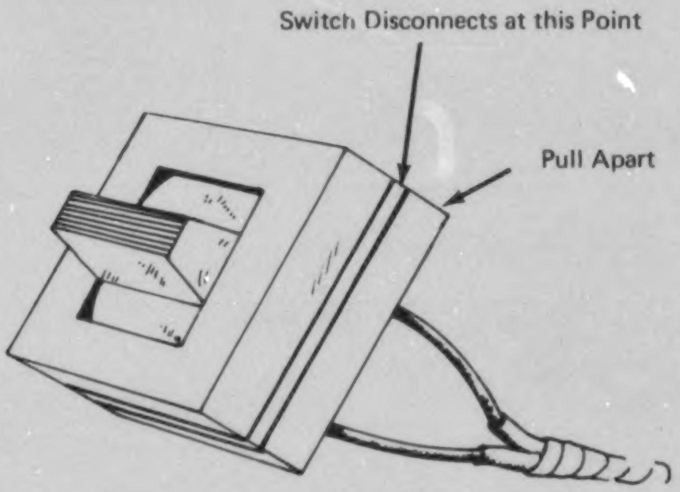
  A. Remove door trim panel (See Unit II, Job Sheet #4.)

JOB SHEET #2

B. Carefully disconnect electric switches

(NOTE: Most electric switches are simply unplugged and remain with the door.) (Figure 1)

FIGURE 1


Switch Disconnects at this Point
Pull Apart

C. Remove dust and water seal cover

D. Remove regulator cam rollers or bolts from sash channel

(NOTE: It may be necessary to remove door glass. If so, see Unit IV, Job Sheets #2 and #3. If it is not necessary, block glass in the up position so it will be out of the way.)

JOB SHEET #2

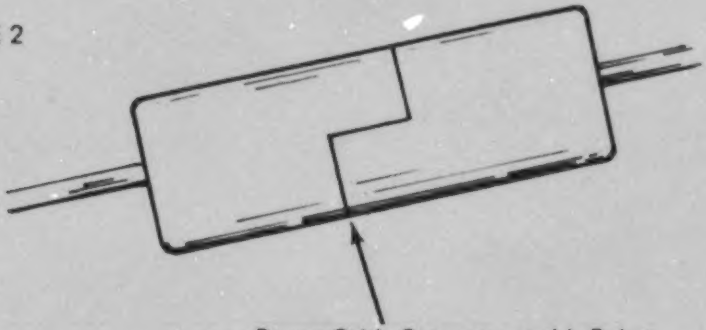
E. Disconnect motor on regulator from electric power source (Figure 2)

   1. Pull plug apart

      (NOTE: Late models will have locking lug.)

   2. Bolt and nut junction block

FIGURE 2



Power Cable Separates at this Point

F. Remove bolts from regulator

   1. Slide out of pivot channel

   2. Remove through opening in door

      (NOTE: On some makes, the center division channel will have to be removed to allow clearance for the regulator to be removed.)

      (CAUTION: Regulators are spring loaded. Do not allow fingers to get caught in the arms or gear movements. See shop manual for recommended procedure.)

G. Remove motor from regulator

   (CAUTION: Set regulator in a vise and lock the arms to prevent spring from unloading. Keep fingers clear at all times to prevent injury. See shop manual for recommended procedure.)

   (NOTE: If motor is bad, replace. If regulator is bad, repair or replace as necessary.)

H. Replace regulator assembly (Reverse steps A-G)

   (NOTE: Always check window glass alignment and operation before installing the trim panel.)

HARDWARE
UNIT III

JOB SHEET #3--REMOVE AND REPLACE A VENT WINDOW ASSEMBLY

I. Tools and equipment needed

  A. Wrenches 1/4"-5/8"

  B. Adjustable wrench 10"

  C. 1/4" drive socket set

  D. 3/8" drive socket set

  E. Phillips screwdriver set

  F. Straight blade screwdriver set

  G. Door handle remover tools

  H. Trim pad remover tools

  I. Hex wrench set

  J. Weather strip adhesive

  K. Trim adhesive

  L. Lubricant (oil, grease)

  M. Awl

II. Procedures

  A. Remove door trim panel (See Unit II, Job Sheet #4.)

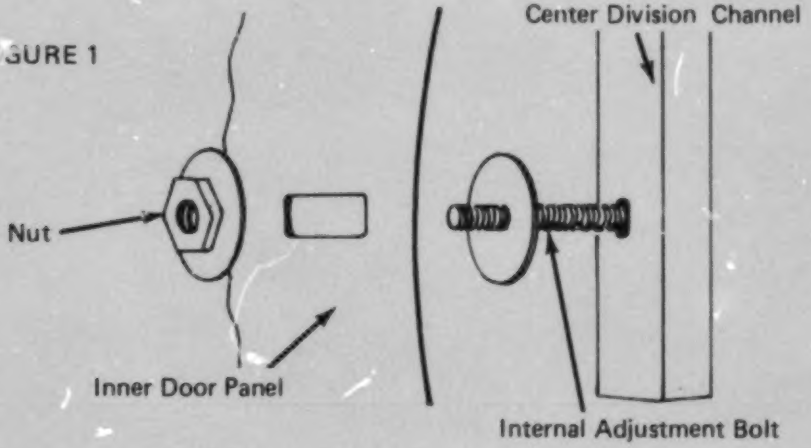
  B. Remove dust and water seal cover

JOB SHEET #3

C. Remove bolt from bottom of center division channel

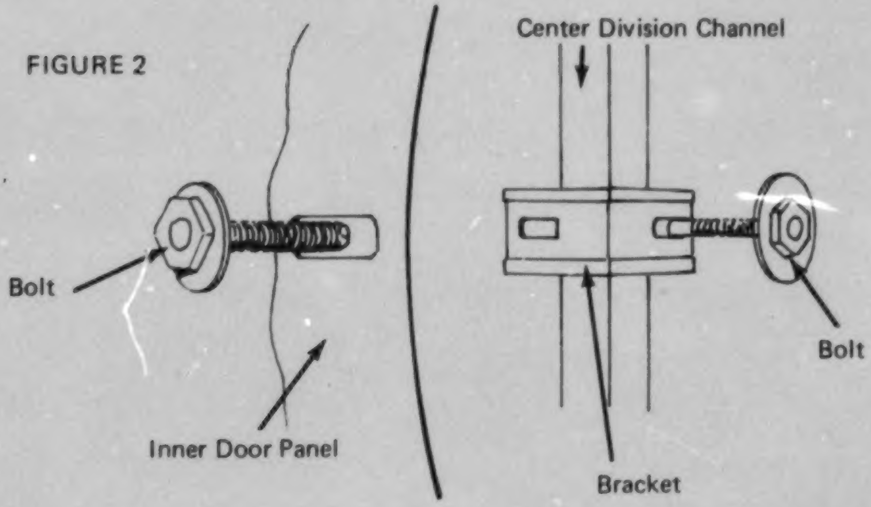
1. On the models with an internal adjustment bolt, remove bolt also (Figure 1)

FIGURE 1


Center Division Channel
Nut
Inner Door Panel
Internal Adjustment Bolt

2. On bracket type models, remove bracket from center division channel (Figure 2)

FIGURE 2

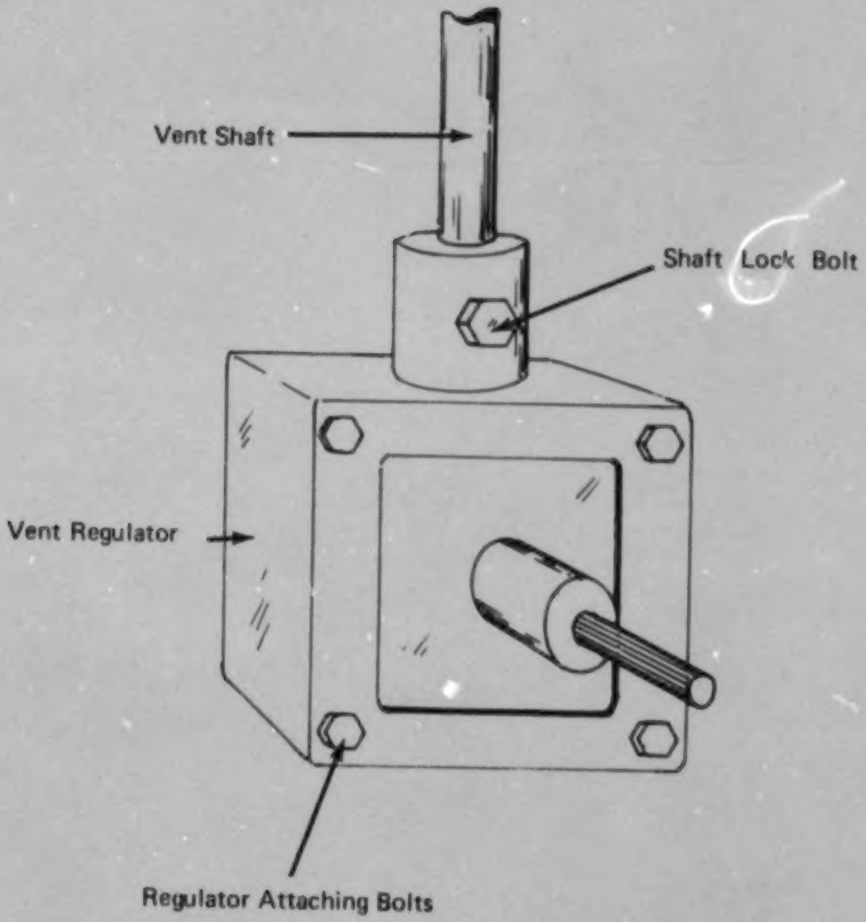

Center Division Channel
Bolt
Bolt
Inner Door Panel
Bracket

JOB SHEET #3

D. Remove vent regulator if required (Figure 3)

1. Remove shaft locking bolt
2. Remove regulator attaching bolts
3. Remove regulator

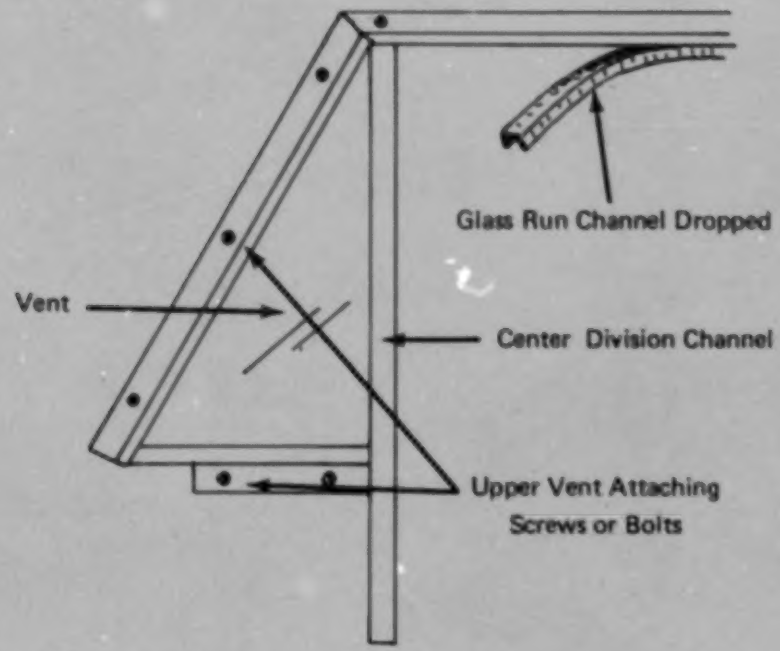
FIGURE 3


Vent Shaft
Shaft Lock Bolt
Vent Regulator
Regulator Attaching Bolts

JOB SHEET #3

E. Remove upper vent bolts and screws (Figure 4)

FIGURE 4


Glass Run Channel Dropped
Vent
Center Division Channel
Upper Vent Attaching
Screws or Bolts

F. Drop glass run channel

(NOTE: See Figure 4.)

G. Remove vent

1. Work vent toward rear of door to gain clearance
2. Remove vent from door

H. Replace vent window assembly (Reverse steps A-G)

(NOTE: When replacing electric vent assembly, check with service manual.)

HARDWARE
UNIT III

JOB SHEET #4--REMOVE AND REPLACE AN INSIDE DOOR REMOTE CONTROL

I. Tools and equipment needed

   A. Wrenches 1/4"-5/8"

   B. Adjustable wrench 10"

   C. 1/4" drive socket set

   D. 3/8" drive socket set

   E. Phillips screwdriver set

   F. Straight blade screwdriver set

   G. Door handle remover tools

   H. Trim pad remover tools

   I. Hex wrench set

   J. Weather strip adhesive

   K. Trim adhesive

   L. Lubricant (oil, grease)

   M. Awl

II. Procedure

   A. Remove door trim panel (See Unit II, Job Sheet #4.)

   B. Remove dust and water seal cover

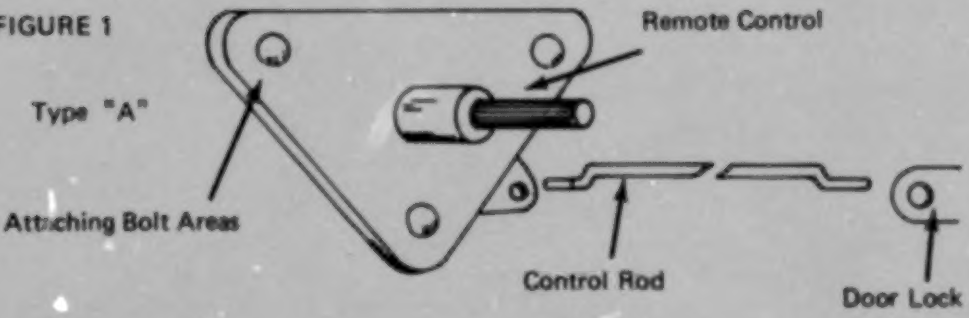
JOB SHEET #4

C. Remove remote control

1. Type "A" (Figure 1)
    a. Remove attaching bolts
    b. Twist remote control off rod

FIGURE 1

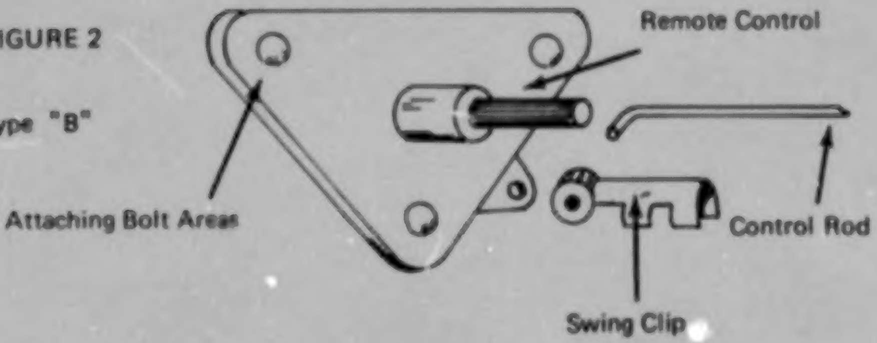
Type "A"


Remote Control
Attaching Bolt Areas
Control Rod
Door Lock

2. Type "B" (Figure 2)
    a. Remove attaching bolts
    b. Remove swing clip from rod
    c. Remove remote control

FIGURE 2

Type "B"


Remote Control
Attaching Bolt Areas
Control Rod
Swing Clip

JOB SHEET #4

3. Type "C" (Figure 3)

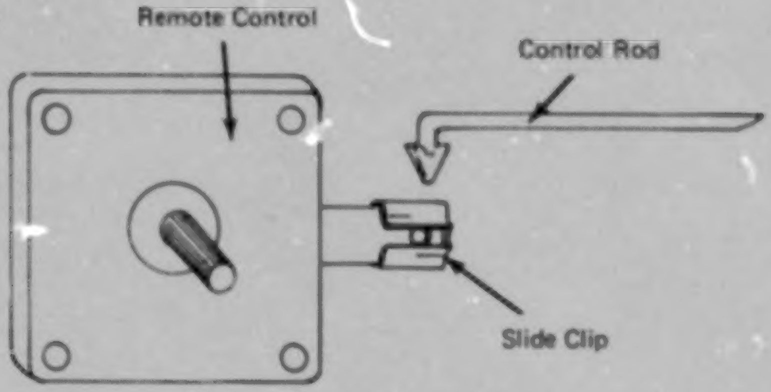
   a. Slide clip off remote control

   b. Remove attaching bolts

   c. Remove remote control

FIGURE 3

Type "C"



(NOTE: Side clip is installed and the control rod is pushed through the hole in the arm and retained by the clip.)

(IMPORTANT: Do not bend control rods or break clips. Bent rods will result in the door not working properly and clips are not available for replacement.)

D. Replace remote control (Reverse steps A-C)

HARDWARE
UNIT III

JOB SHEET #5–REMOVE AND REPLACE A DOOR LOCK CYLINDER

I. Tools and equipment needed

   A. Wrenches 1/4"-5/8"

   B. Adjustable wrench 10"

   C. 1/4" drive socket set

   D. 3/8" drive socket set

   E. Phillips screwdriver set

   F. Straight blade screwdriver set

   G. Door handle remover tools

   H. Trim pad remover tools

   I. Hex wrench set

   J. Weather strip adhesive

   K. Trim adhesive

   L. Lubricant (oil, grease)

   M. Awl

II. Procedure

   A. Remove door trim panel (See Unit II, Job Sheet #4.)

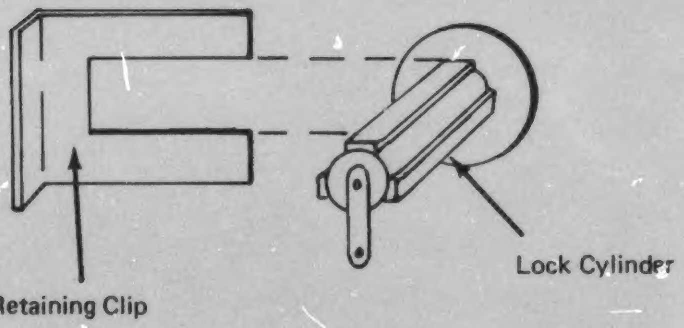
   B. Remove dust and water seal cover

   C. Locate lock cylinder retaining clip

JOB SHEET #5

D. Slide retaining clip off lock (Figure 1)

FIGURE 1


Retaining Clip
Lock Cylinder

E. Remove lock from door

F. Replace lock (Reverse steps A-D)

HARDWARE
UNIT III

JOB SHEET #6--REMOVE AND REPLACE A DOOR LATCH

I. Tools and equipment needed

- A. Wrenches 1/4"-5/8"
- B. Adjustable wrench 10"
- C. 1/4" drive socket set
- D. 3/8" drive socket set
- E. Phillips screwdriver set
- F. Straight blade screwdriver set
- G. Door handle remover tools
- H. Trim pad remover tools
- I. Hex wrench set
- J. Weather strip adhesive
- K. Trim adhesive
- L. Lubricant (oil, grease)
- M. Awl

II. Procedure

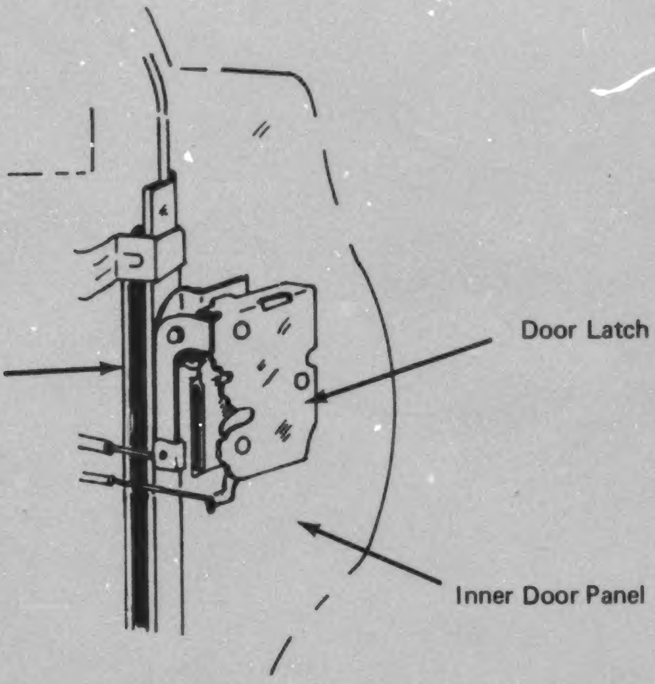
- A. Remove door trim panel (See Unit II, Job Sheet #4.)
- B. Remove dust and water seal cover
- C. Remove inside door remote control
- D. Remove door lock cylinder

  (NOTE: On some models, this step is not necessary. Carefully inspect the requirements of each job.)

JOB SHEET #6

E. Remove run channel if necessary (Figure 1)

FIGURE 1



(NOTE: Sometimes the glass run channel is too close to the lock to allow removal. Remove retaining bolts and pull out of the way as necessary. Carefully inspect the requirements of each job.)

F. Remove door latch

   1. Remove retaining bolts

   2. Remove latch from door

G. Replace latch (Reverse steps A-F)

(NOTE: Always lubricate latch and working parts with waterproof grease.)

HARDWARE
UNIT III

JOB SHEET #7--REMOVE AND REPLACE AN OUTSIDE DOOR HANDLE

I. Tools and equipment needed

- A. Wrenches 1/4"-5/8"
- B. Adjustable wrench 10"
- C. 1/4" drive socket set
- D. 3/8" drive socket set
- E. Phillips screwdriver set
- F. Straight blade screwdriver set
- G. Door handle remover tools
- H. Trim pad remover tools
- I. Hex wrench set
- J. Weather strip adhesive
- K. Trim adhesive
- L. Lubricant (oil, grease)
- M. Awl

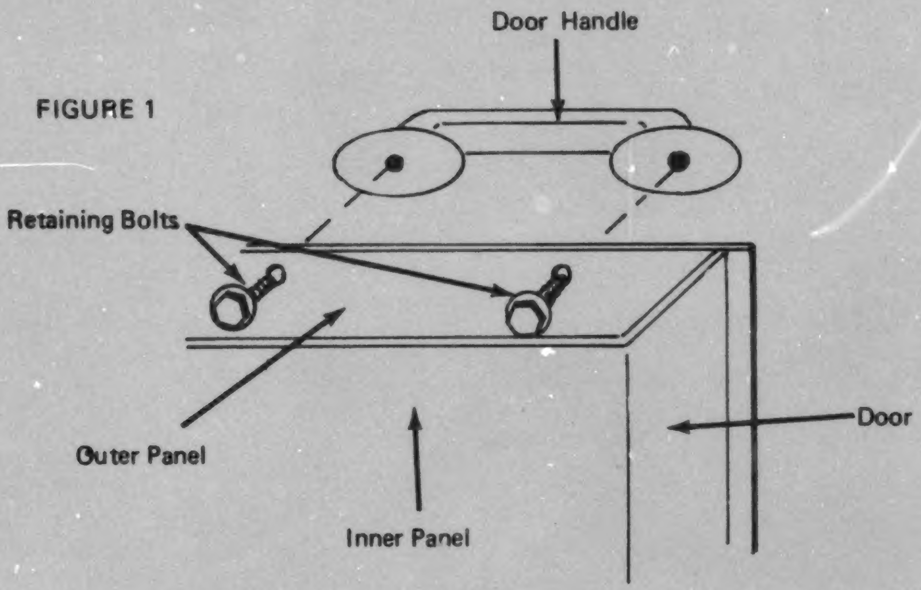
II. Procedure

- A. Remove door trim panel (See Unit II, Job Sheet #4.)
- B. Remove dust and water seal cover

JOB SHEET #7

C. Remove door handle retaining bolts (Figure 1)

FIGURE 1


Door Handle
Retaining Bolts
Outer Panel
Inner Panel
Door

D. Remove handle

E. Replace handle (Reverse steps A-D)

HARDWARE
UNIT III

JOB SHEET #8--REMOVE AND REPLACE A CENTER DIVISION CHANNEL

I. Tools and equipment needed

   A. Wrenches 1/4"-5/8"

   B. Adjustable wrench 10"

   C. 1/4" drive socket set

   D. 3/8" drive socket set

   E. Phillips screwdriver set

   F. Straight blade screwdriver set

   G. Door handle remover tools

   H. Trim pad remover tools

   I. Hex wrench set

   J. Weather strip adhesive

   K. Trim adhesive

   L. Lubricant (oil, grease)

   M. Awl

II. Procedure

   A. Remove door trim panel (See Unit II, Job Sheet #4.)

   B. Remove dust and water cover

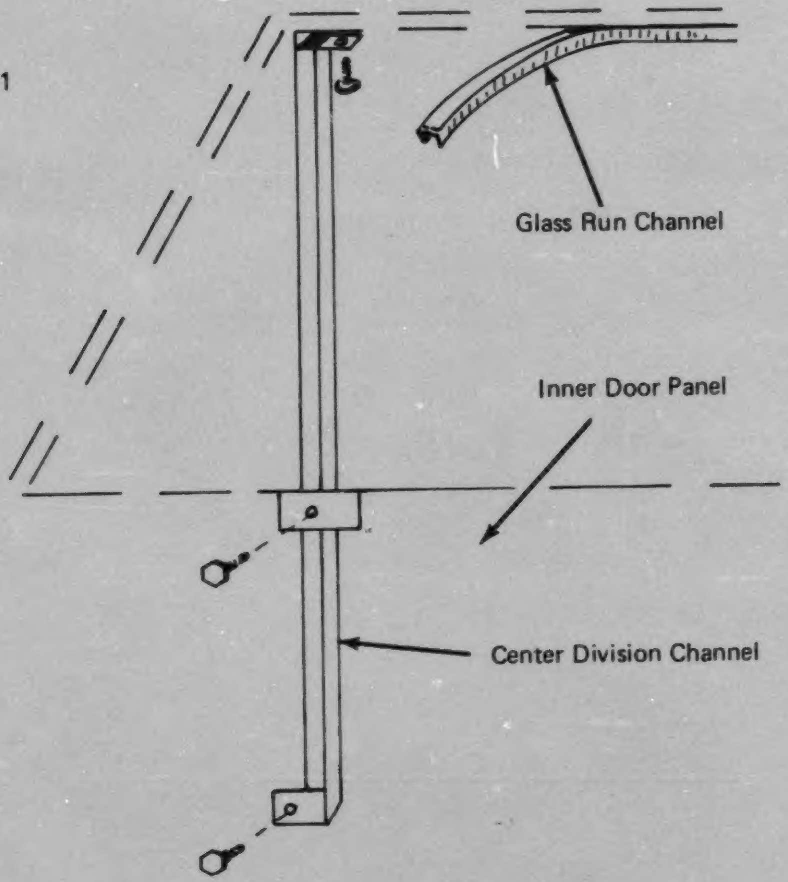
JOB SHEET #8

C. Drop glass run channel (Figure 1)

D. Remove bolts from center division channel

(NOTE: Some center division channels are part of the vent assembly. If so, vent must be removed.)

FIGURE 1


Glass Run Channel
Inner Door Panel
Center Division Channel

E. Remove center division channel

F. Replace center division channel (Reverse steps A-E)

HARDWARE
UNIT III

JOB SHEET #9–REMOVE AND REPLACE A RUN CHANNEL

I. Tools and equipment needed

- A. Wrenches 1/4"-5/8"
- B. Adjustable wrench 10"
- C. 1/4" drive socket set
- D. 3/8" drive socket set
- E. Phillips screwdriver set
- F. Straight blade screwdriver set
- G. Door handle remover tools
- H. Trim pad remover tools
- I. Hex wrench set
- J. Weather strip adhesive
- K. Trim adhesive
- L. Lubricant (oil, grease)
- M. Awl

II. Procedure

- A. Remove door trim panel (See Unit II, Job Sheet #4.)
- B. Remove dust and water cover
- C. Remove door glass (See Unit IV, Job Sheets #2 and #3.)

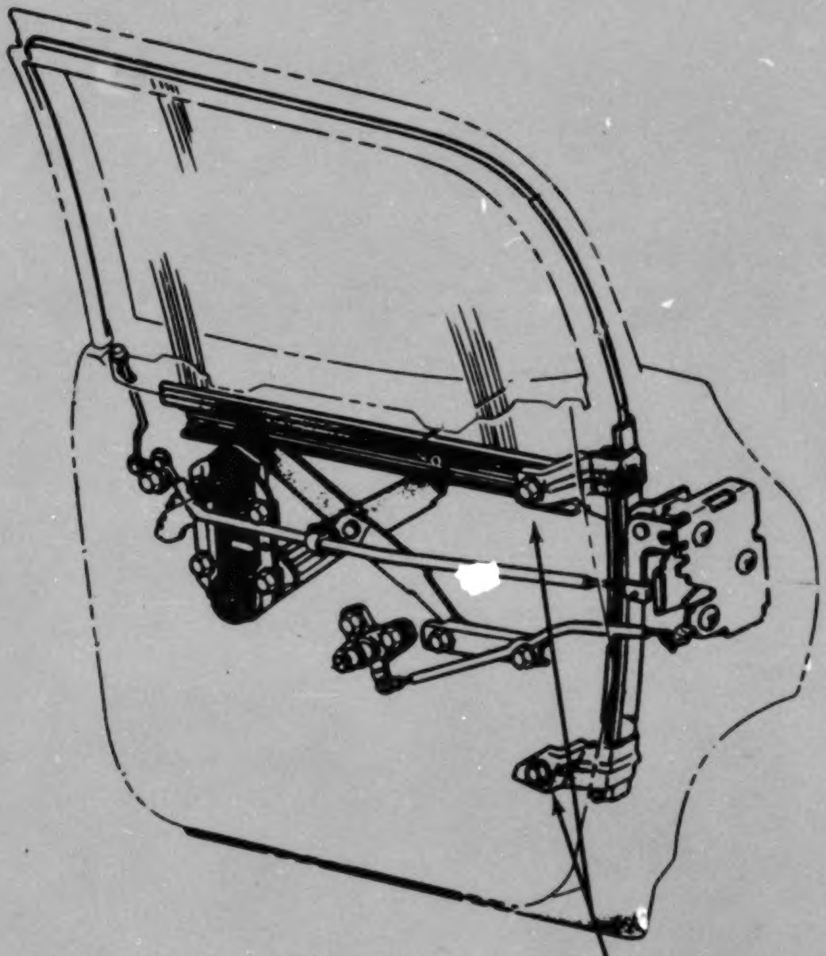
  (NOTE: On some makes, it is not necessary to remove door glass. Check with your instructor before removing glass.)

JOB SHEET #9

D. Remove run channel (Figure 1)

1. Remove retaining bolts

FIGURE 1



Retaining Bolts

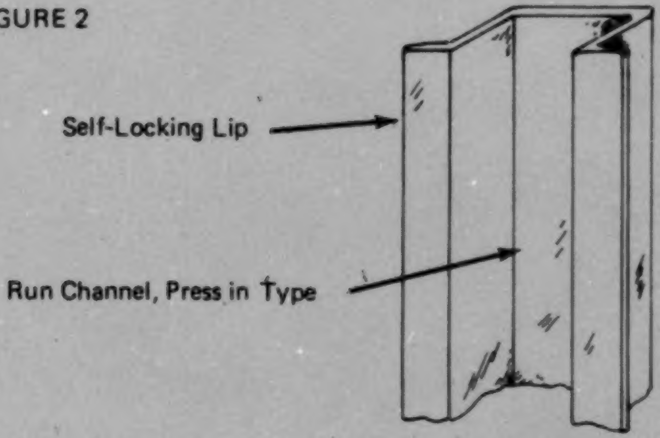
2. Remove channel and retaining clips by prying with screwdriver

JOB SHEET #9

3. Remove run channel from door (Figure 2)

   (NOTE: Some run channels press in place. To remove, just pull out and install new one.)

FIGURE 2


Self-Locking Lip
Run Channel, Press in Type

E. Replace run channel (Reverse steps A-D)

HARDWARE
UNIT III

JOB SHEET #10–REMOVE AND REPLACE A DOOR WEATHER STRIP

I. Tools and equipment needed

   A. Wrenches 1/4"-5/8"

   B. Adjustable wrench 10"

   C. 1/4" drive socket set

   D. 3/8" drive socket set

   E. Phillips screwdriver set

   F. Straight blade screwdriver set

   G. Door handle remover tools

   H. Trim pad remover tools

   I. Hex wrench set

   J. Weather strip adhesive

   K. Trim adhesive

   L. Lubricant (oil, grease)

   M. Awl

II. Procedure

   A. Remove door from car and place on bench

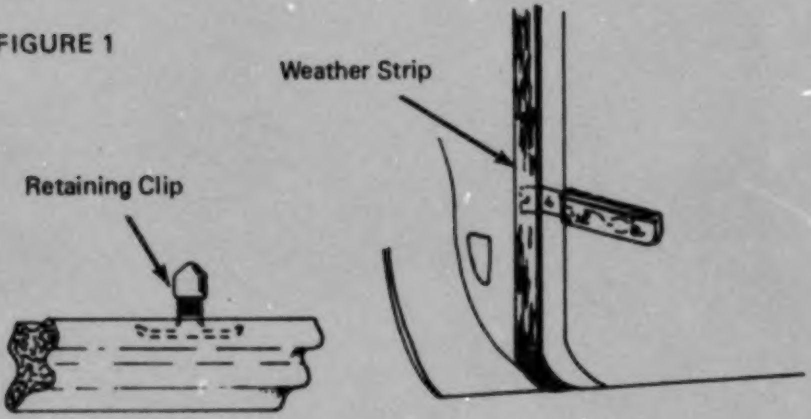
   (NOTE: Provide protection for trim and paint to prevent unneeded repairs.)

JOB SHEET #10

B. Remove old damaged weather strip

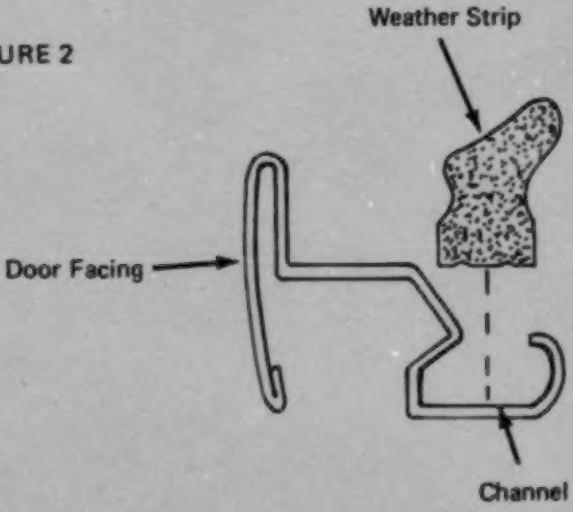
1. For retainer type use special tool (Figure 1)

FIGURE 1


Weather Strip
Retaining Clip

2. Remove glue type channel with a putty knife (Figure 2)

FIGURE 2


Weather Strip
Door Facing
Channel

JOB SHEET #10

C. Install new weather strip

(NOTE: Be sure channel is clean before installing new weather strip.)

1. Retainer type

   a. Push retainer in holes

   b. Glue loose areas with weather strip adhesive

   (NOTE: Coat both the door and weather strip lightly with glue. Press weather strip on door firmly.)

   c. Install door on vehicle

2. Glue type

   a. Lightly coat weather strip with weather strip cement

   b. Coat channel with weather strip cement

   c. Press weather strip into channel

   (NOTE: Be sure weather strip fits channel correctly.)

   d. Install door on vehicle

   (NOTE: Weather strip can be replaced on some models without removing doors. But to insure proper installation, it is usually better to remove doors. Always align and adjust doors properly when job is complete.)

HARDWARE
UNIT III

TEST

1. Match the following terms to the correct definitions

_____a. Channel that is attached to the bottom of any door, quarter, or tailgate glass

_____b. Gear operated mechanism which lowers and raises the glass

_____c. Rollers or slide block which run in channels and guides

_____d. Cushioned strip used to stabilize the window and to prevent rattling when window is lowered

_____e. Upper or lower, used to prevent the glass from rolling out the top or off the bottom guides

_____f. Door latch or key lock

_____g. Pivot channel which is adjustable to allow for adjustment of glass

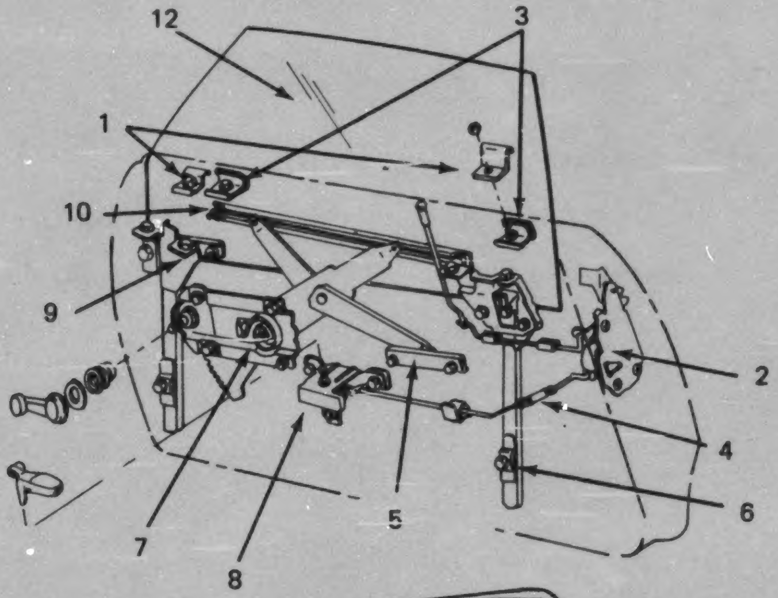
_____h. Door inner or outer opener

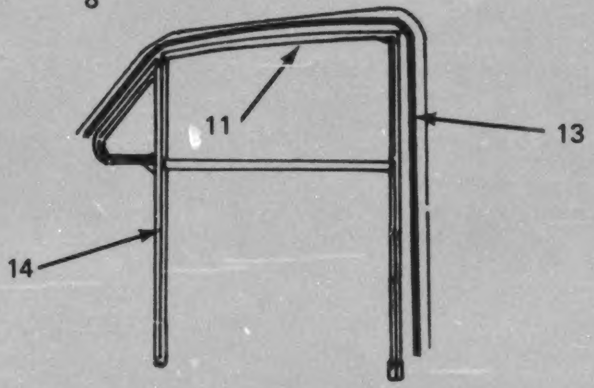
_____i. Used in place of center division channel and run channel to guide glass up and down

_____j. Any device used to open or lock latches using a system of rods and levers away from the lock

1. Remote control
2. Lock
3. Stabilizer strip
4. Regulator
5. Stop
6. Door handle
7. Cam
8. Equalizer arm
9. Lower sash channel
10. Guides

2. Identify interior hardware by placing the correct numbers in the blanks provided.





______a. Window assembly

______b. Stabilizer strips

______c. Trim pad adjusting plates

______d. Lower sash channel cam

______e. Front guide

______f. Window regulator

______g. Door latch remote control

______h. Inner panel cam

______i. Rear guide

______j. Adjustable remote control to latch rod

______k. Door latch

______l. Center division channel

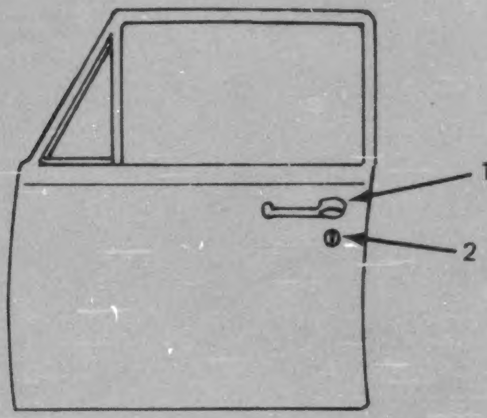
______m. Run channel

______n. Weather strip

3. Identify exterior hardware by placing the correct numbers in the blanks provided.

   ______a. Outside key door lock

   ______b. Outside door handle



4. Demonstrate the ability to:

   a. Remove and replace a manual window regulator.

   b. Remove and replace an electric window regulator.

   c. Remove and replace a vent window assembly.

   d. Remove and replace an inside door remote control.

   e. Remove and replace a door lock cylinder.

   f. Remove and replace a door latch.

   g. Remove and replace an outside door handle.

   h. Remove and replace a center division channel.

   i. Remove and replace run channels.

   j. Remove and replace a door weather strip.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

HARDWARE
UNIT III

ANSWERS TO TEST

1.
   a. 9
   b. 4
   c. 7
   d. 3
   e. 5
   f. 2
   g. 8
   h. 6
   i. 10
   j. 1

2.
   a. 12
   b. 3
   c. 1
   d. 10
   e. 9
   f. 7
   g. 8
   h. 5
   i. 6
   j. 4
   k. 2
   l. 14
   m. 11
   n. 13

3.
   a. 2
   b. 1

4. Performance skills will be evaluated according to the criteria listed in the progress chart.

GLASS
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms associated with automobile glass to a list of definitions, identify the type of glass used in automobiles, analyze problems requiring glass adjustment, and identify the methods of installing glass. He should be able to remove and replace vent glass, door glass, tailgate glass, windshields, and back glass. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with automobile glass to a list of definitions.
2. List two reasons for adjusting windows.
3. Describe the problem that usually exists when a window is stuck and will not raise or lower.
4. Describe the ways door glass is held to the door regulator.
5. Name the two types of glass used for doors.
6. Describe two methods for installing a gasket type windshield or back glass.
7. Describe two methods for removing a butyl or acrylic caulking installed windshield or back glass.
8. Demonstrate the ability to:
    a. Remove and replace a vent glass.
    b. Remove and replace a door glass with a vent glass.
    c. Remove and replace a door glass without a vent glass.
    d. Remove and replace a rear tailgate glass.
    e. Remove and replace a gasket type windshield or back glass.
    f. Remove and replace a gasketless type windshield or back glass.

GLASS
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1--Glass Hardware Gasket Type

      2. TM 2--Glass Hardware Bolt Type

      3. TM 3--Glass Hardware Vent Type

      4. TM 4--Vent Removal

D. Job sheets

1. Job Sheet #1--Remove and Replace a Vent Glass
2. Job Sheet #2--Remove and Replace a Door Glass With a Vent Glass
3. Job Sheet #3--Remove and Replace a Door Glass Without a Vent Glass
4. Job Sheet #4--Remove and Replace a Rear Tailgate Glass
5. Job Sheet #5--Remove and Replace a Gasket Type Windshield or Back Glass
6. Job Sheet #6--Remove and Replace a Gasketless Type Windshield or Back Glass

E. Test

F. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Co., 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill, Inc., 1971.

D. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

F. Tait, A., A. G. Deroche, and N. N. Hildebrand. *The Principles of Auto Body Repairing and Repainting.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

GLASS
UNIT IV

INFORMATION SHEET

I. Terms and definitions (Transparencies 1, 2, 3, and 4)

  A. Glass-run channel--Channel in which the glass runs between the top and side of the door to prevent breakage

  B. Center division channel--Channel between the door glass and vent glass

  C. Regulator--Mechanical device, hand or motor operated, used to raise or lower door glass or to open and close vent glass

  D. Sash channel--Channel used to fasten the door glass to the regulator

  E. Cam--Rollers which operate in the sash channel and in other channels allowing the glass to be raised or lowered

  F. Ventilator--Small vent (wing) glass that opens and shuts to allow a vacuum and air circulation with the door glass up

  (NOTE: It also deflects the air current when the door glass is down making the passenger compartment more comfortable.)

II. Reasons for adjusting windows

  A. Fits the window to the door for weather protection

  B. Allows the window to open and close with minimal effort

III. Problem that usually exists when a window is stuck and will not raise or lower--The window regulator pivot channel is out of adjustment

IV. Ways door glass is held to the door regulator (Transparency 3)

  A. Cam rollers with retaining clips

  B. Retaining shoulder type bolts with plastic bushings

  C. Sash channel bonded to glass

V. Types of glass used for doors

  A. Laminated vinyl safety glass

  B. Tempered safety plate

INFORMATION SHEET

VI. Methods for installing a gasket type windshield or back glass

   A. Drawstring method

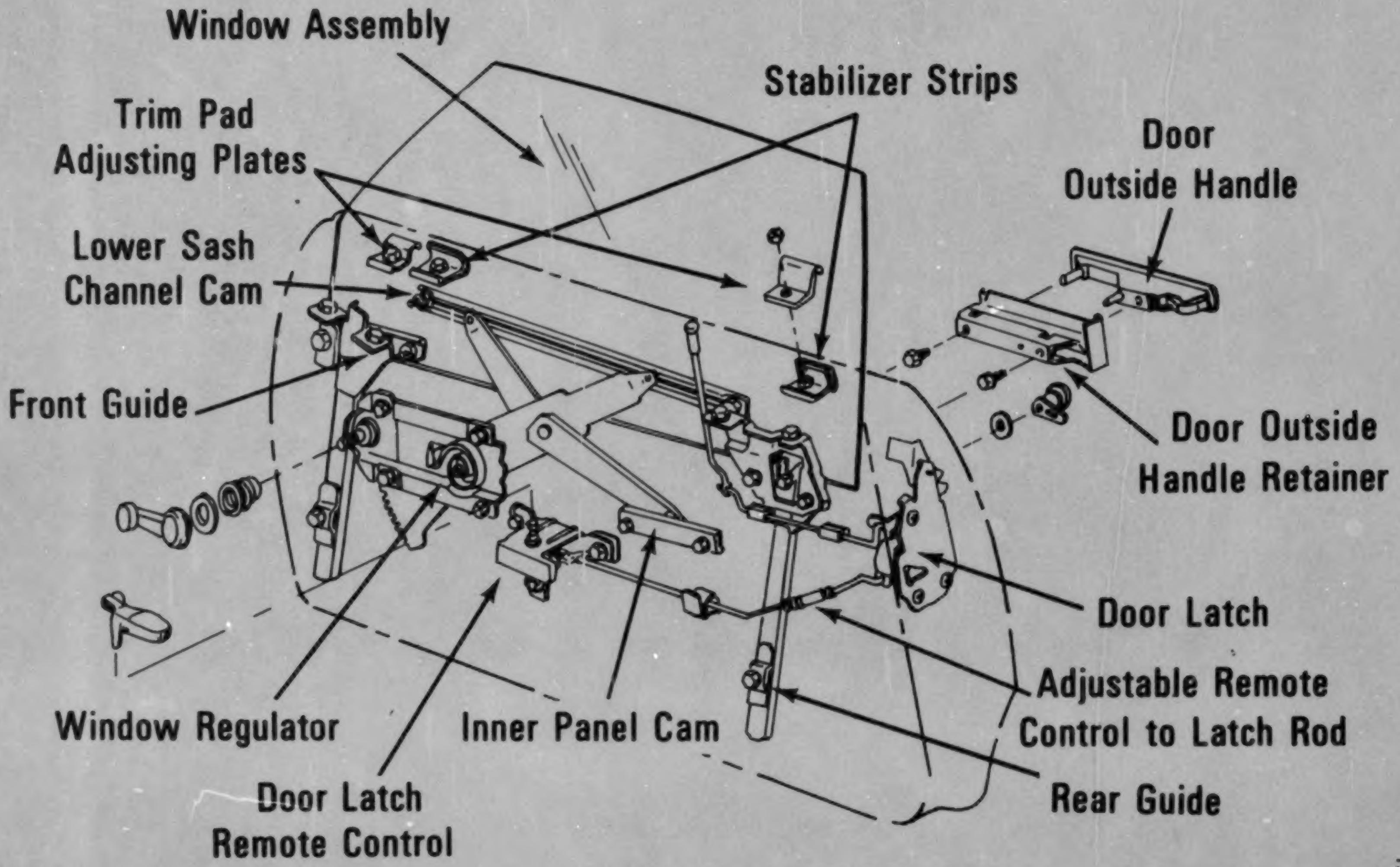
   B. Weather strip inserting tool

VII. Methods for removing a butyl or acrylic caulking installed windshield

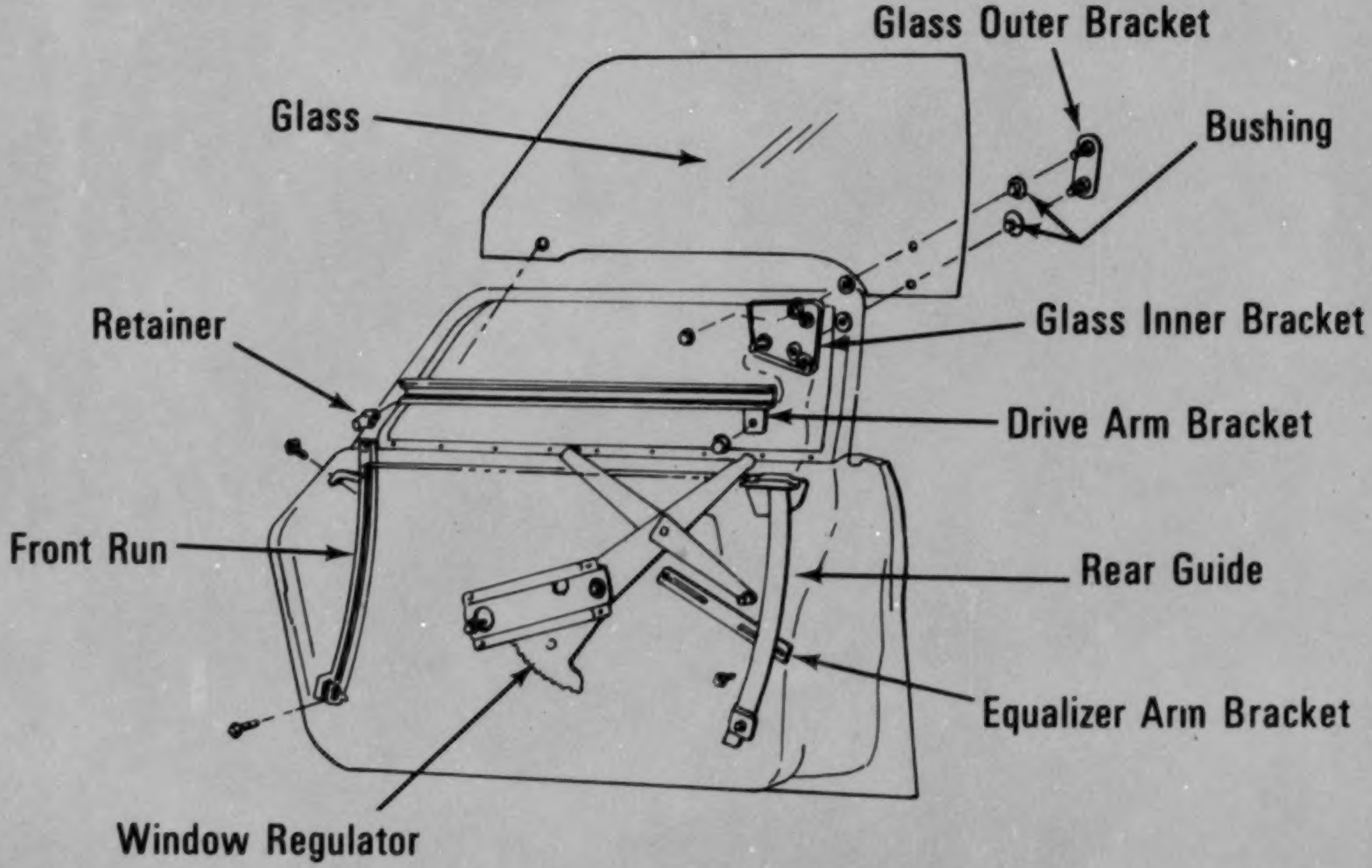
   A. Cutting with piano wire

   B. Cutting with hot or cold knife

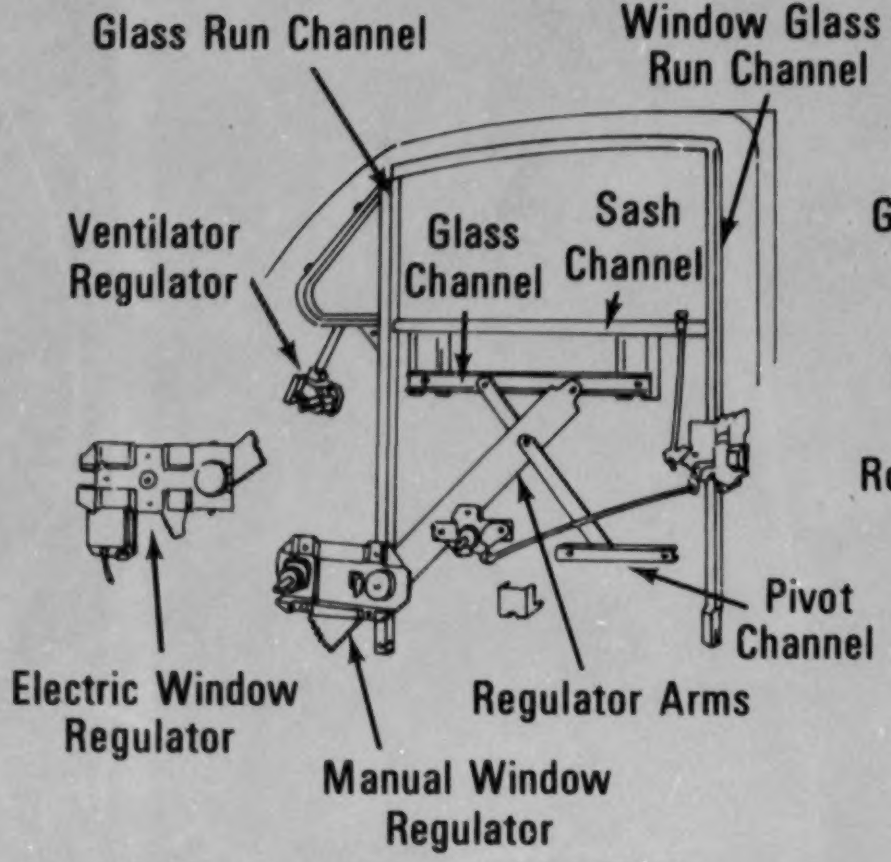
Glass Hardware Gasket Type

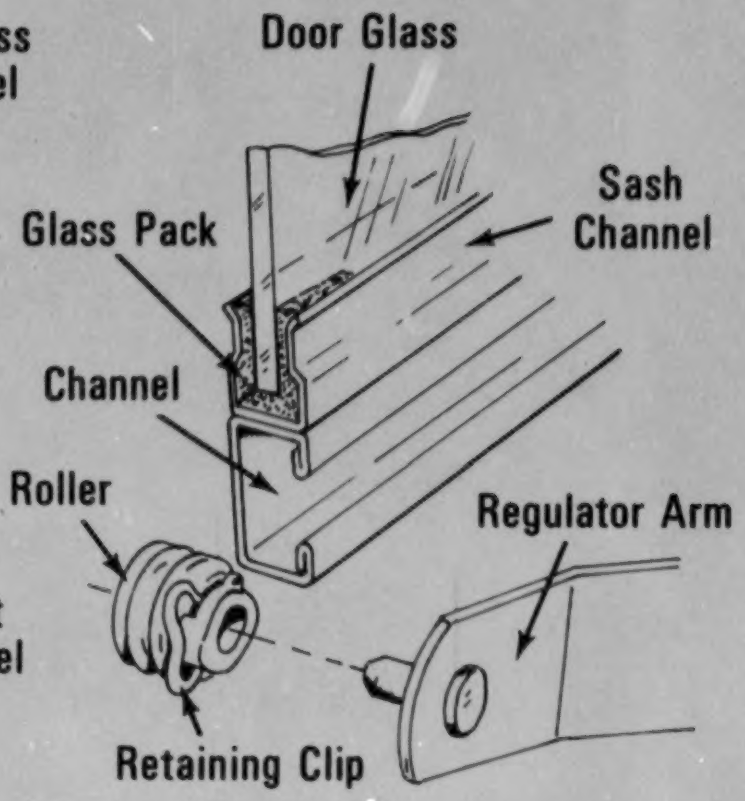

Window Assembly
Stabilizer Strips
Trim Pad
Adjusting Plates
Door
Outside Handle
Lower Sash
Channel Cam
Front Guide
Door Outside
Handle Retainer
Door Latch
Adjustable Remote
Control to Latch Rod
Window Regulator
Inner Panel Cam
Rear Guide
Door Latch
Remote Control

Glass Hardware Bolt Type

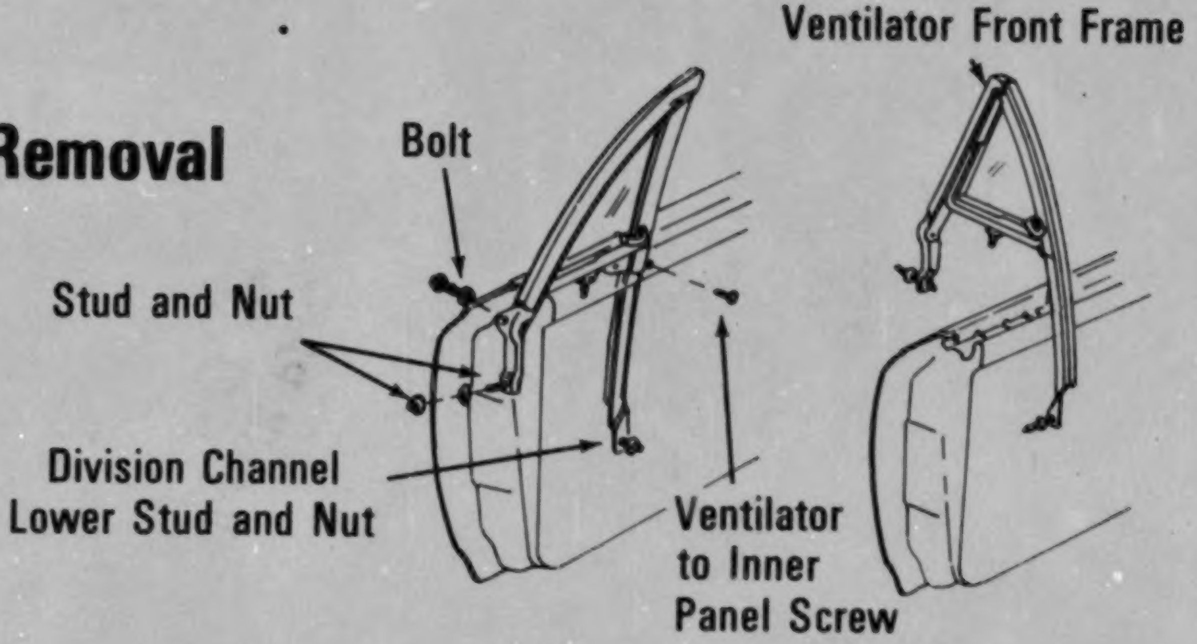

Glass Outer Bracket
Glass
Bushing
Glass Inner Bracket
Retainer
Drive Arm Bracket
Front Run
Rear Guide
Equalizer Arm Bracket
Window Regulator

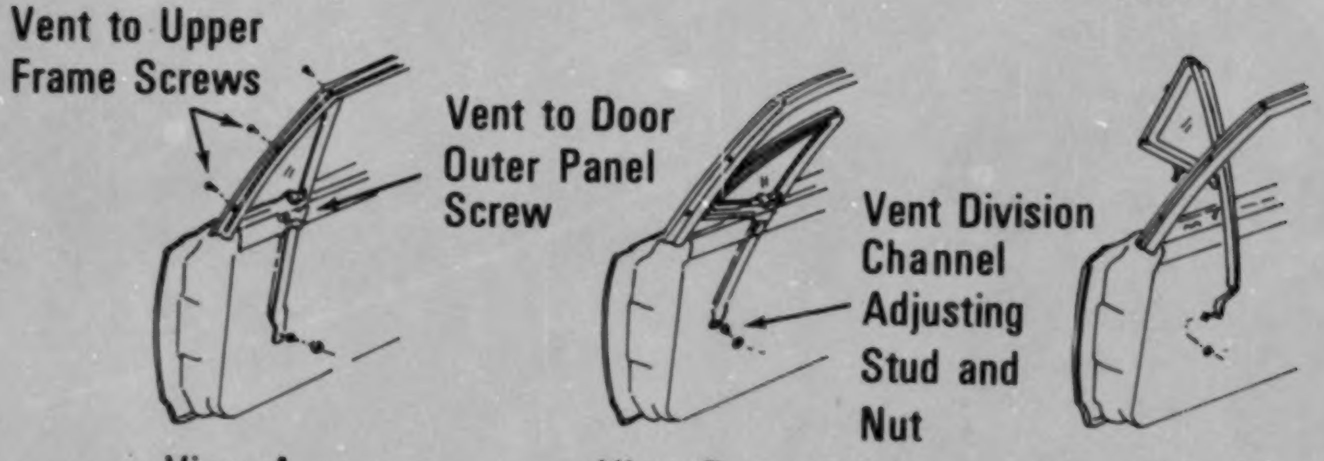
Glass Hardware Vent Type


Glass Run Channel
Window Glass Run Channel
Ventilator Regulator
Glass Channel
Sash Channel
Electric Window Regulator
Manual Window Regulator
Regulator Arms
Pivot Channel


Door Glass
Glass Pack
Sash Channel
Channel
Roller
Regulator Arm
Retaining Clip

Vent Removal


Bolt
Stud and Nut
Division Channel Lower Stud and Nut
Ventilator to Inner Panel Screw
Ventilator Front Frame


Vent to Upper Frame Screws
Vent to Door Outer Panel Screw
Vent Division Channel Adjusting Stud and Nut

View A

View B

View C

GLASS
UNIT IV

JOB SHEET #1--REMOVE AND REPLACE A VENT GLASS

I. Tools and materials needed

   A. Wrenches 1/4"-5/8"

   B. Adjustable wrench 10"

   C. 1/4" drive socket set

   D. 3/8" drive socket set

   E. Phillips screwdriver set

   F. Straight blade screwdriver set

   G. Door handle remover tools

   H. Trim pad remover tools

   I. Hex wrench set

   J. Weather strip adhesive

   K. Trim adhesive

   L. Lubricant (oil, grease)

   M. Awl

   N. Glass puller

   O. Glass vise

II. Procedure

   (NOTE: Some vent windows bolt in with nylon bushings and do not require removal of vent assembly.)

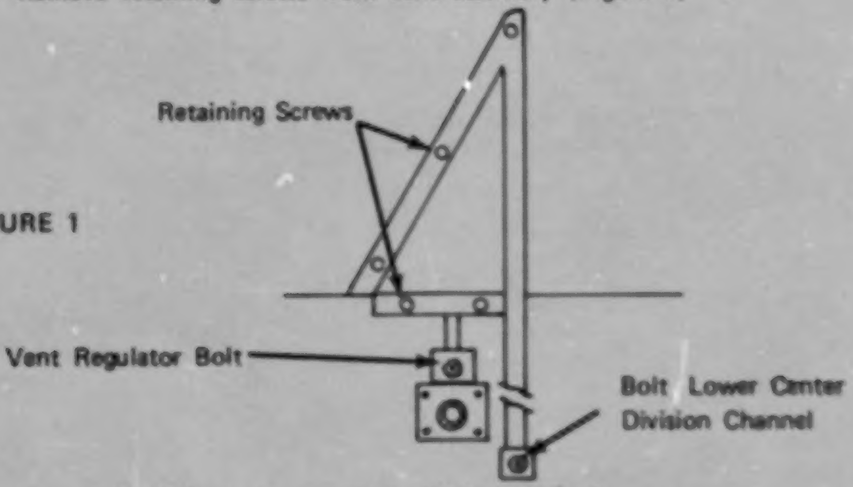
   A. Remove door trim panel (See Unit III, Job Sheet #4.)

   B. Remove dust and water seal cover

JOB SHEET #1

C. Remove retaining screws from vent assembly (Figure 1)

FIGURE 1


Retaining Screws
Vent Regulator Bolt
Bolt Lower Center Division Channel

D. Remove bolt from lower center division channel

(NOTE: See Figure 1.)

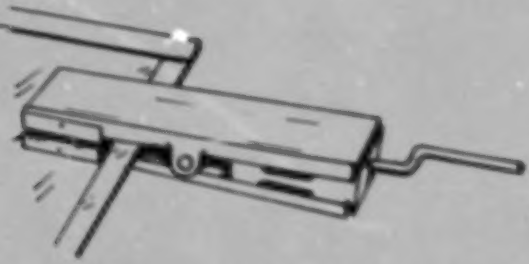
E. Remove bolt from vent regulator

F. Work vent loose from door and remove

(NOTE: Some makes and models of vehicles differ in the way the vents are retained. Be sure everything is removed that could result in damage to glass channels or other trim. Always check a manual to see how the glass is retained.)

G. Remove glass from vent using a glass pulling tool (Figure 2)

FIGURE 2


Glass Pulling Tool

(NOTE: If a pulling tool is not available, use a small screwdriver and hammer to remove the glass from the channel. Be careful not to spring or bend the channel.)

(CAUTION: Always protect hands and eyes when removing glass.)

JOB SHEET #1

H. Install vent glass

1. Place glass tape around vent

   (NOTE: Use the same thickness as was used in the original installation.)

2. Drive glass into vent channel

   a. Retain channel in glass vise if available

   b. Drive with a soft rubber mallot

      (CAUTION: Always protect hands and eyes when working with glass.)

   c. Trim excess tape from vent glass

I. Install vent assembly (Reverse steps F thru A)

(NOTE: Always raise and lower door glass and operate the vent in case adjustment is necessary.)

GLASS
UNIT IV

JOB SHEET #2--REMOVE AND REPLACE A DOOR GLASS WITH A VENT GLASS

I. Tools and materials needed

- A. Wrenches 1/4"-5/8"
- B. Adjustable wrench 10"
- C. 1/4" drive socket set
- D. 3/8" drive socket set
- E. Phillips screwdriver set
- F. Straight blade screwdriver set
- G. Door handle remover tools
- H. Trim pad remover tools
- I. Hex wrench set
- J. Weatherstrip adhesive
- K. Trim adhesive
- L. Lubricant (oil, grease)
- M. Awl
- N. Glass puller
- O. Glass vise

II. Procedure

- A. Remove door trim panel (See Unit II, Job Sheet #4.)
- B. Remove dust and water seal cover
- C. Remove center division channel (See Job Sheet #1.)

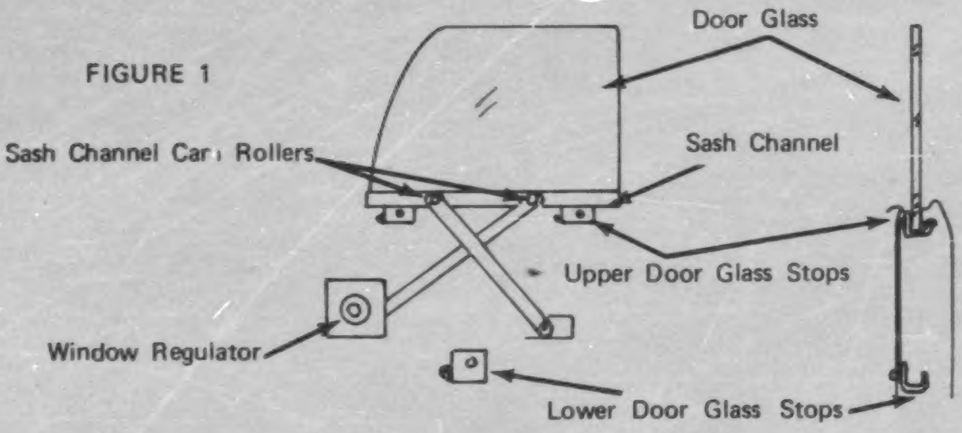
  (NOTE: Some models and makes require the removal of the vent assembly. For other models and makes, the center division channel is separate from the vent assembly.)

JOB SHEET #2

D. Remove door glass upper and lower stops (Figure 1)

(NOTE: Some stops are retained on the sash channel, and some are on the door.)

FIGURE 1


Door Glass
Sash Channel Cam Rollers
Sash Channel
Upper Door Glass Stops
Window Regulator
Lower Door Glass Stops

E. Remove regulator cam rollers or bolts from door sash channel

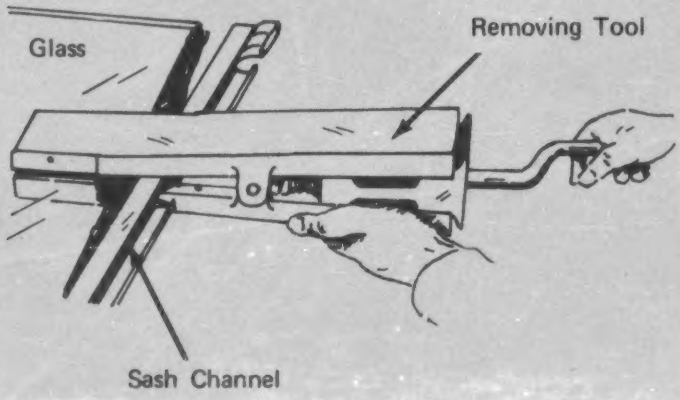
(NOTE: See Figure 1.)

F. Remove glass from door

G. Remove sash channel from glass

1. Use glass removing tool (Figure 2)

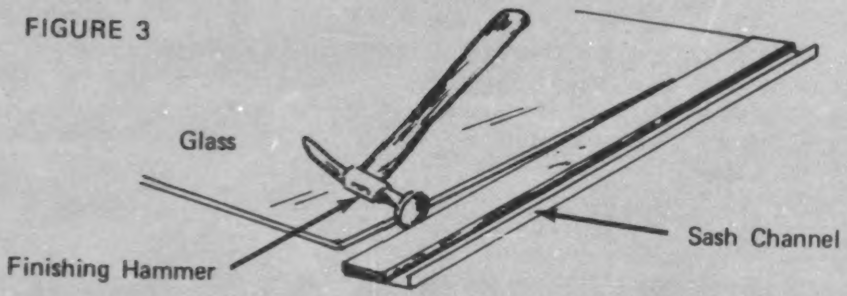
FIGURE 2


Glass
Removing Tool
Sash Channel

JOB SHEET #2

2. Use hammer to drive channel from glass (Figure 3)

FIGURE 3


Glass
Finishing Hammer
Sash Channel

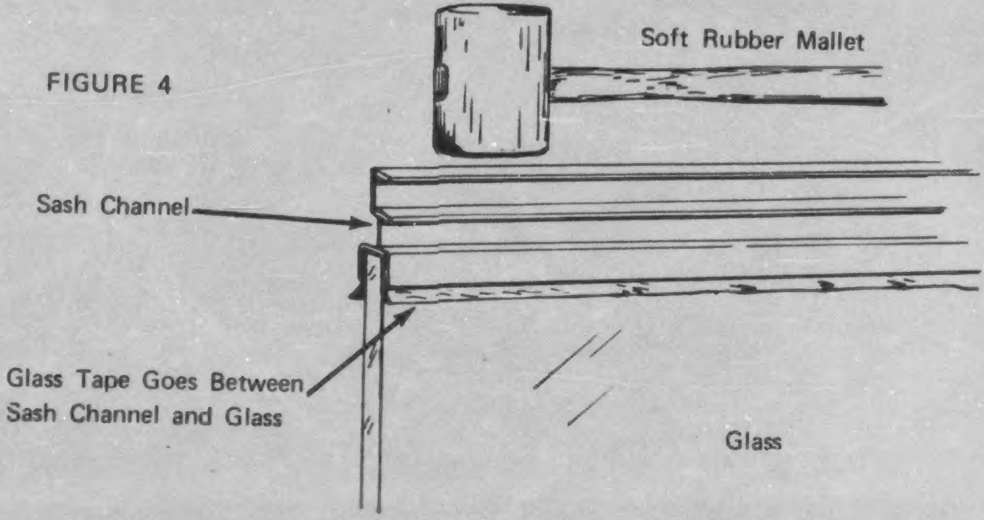
(NOTE: Do not spring or bend channel.)

(CAUTION: Always protect hands and eyes when working with glass.)

H. Install sash channel on new glass (Figure 4)

(NOTE: Use a glass vise if available to hold glass. Drive sash channel on glass with a soft rubber mallot. Use the same thickness of glass tape as was used on the originall.)

FIGURE 4


Soft Rubber Mallet
Sash Channel
Glass Tape Goes Between
Sash Channel and Glass
Glass

JOB SHEET #2

I. Trim excess tape from glass

J. Replace glass in door (Reverse steps F thru A)

(NOTE: Some door glass is retained only by bolts and nylon bushings. In this case, remove broken glass by removing bolts and install new glass. Always be sure nylon bushing is in place. Always be sure door glass will raise and lower properly and that it fits the opening and channel. Adjust if necessary. Lubricate all moving parts. Check all glass channels and replace if worn.)

GLASS
UNIT IV

JOB SHEET #3--REMOVE AND REPLACE A DOOR GLASS WITHOUT A VENT GLASS

I. Tools and materials needed

   A. Wrenches 1/4"-5/8"

   B. Adjustable wrench 10"

   C. 1/4" drive socket set

   D. 3/8" drive socket set

   E. Phillips screwdriver set

   F. Straight blade screwdriver set

   G. Door handle remover tools

   H. Trim pad remover tools

   I. Hex wrench set

   J. Weather strip adhesive

   K. Trim adhesive

   L. Lubricant (oil, grease)

   M. Awl

   N. Glass puller

   O. Glass vise

II. Procedure

   A. Remove door trim panel (See Unit II, Job Sheet #4.)

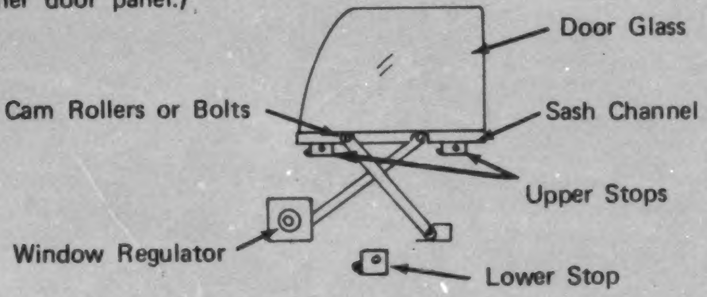
   B. Remove dust and water seal cover

JOB SHEET #3

C. Remove door glass upper and lower stops (Figure 1)

(NOTE: Some stops are retained on the sash channel, and some are on the inner door panel.)

FIGURE 1



D. Remove regulator cam rollers or bolts from sash channel

(NOTE: See Figure 1.)

E. Tilt glass forward and remove from door

(NOTE: Hardtop models will pull straight up.)

F. Remove sash channel from glass

1. Use glass removing tool

2. Use hammer to drive channel from glass

(NOTE: Be very careful not to bend or spring sash channel.)

(CAUTION: Always protect hands and eyes when working with glass.)

G. Install sash channel on glass

(NOTE: Use a glass vise if available to hold glass. Drive sash channel on glass with a soft rubber mallot. Use the same thickness of glass tape as was used on the original.)

H. Trim off excess tape from glass

I. Replace glass in door (Reverse steps F thru A)

(NOTE: Some door glass is retained only by bolts and nylon bushings. In this case, remove broken glass by removing bolts and install new glass. Always be sure nylon bushings are in place. Always be sure door glass will raise and lower properly and that it fits the opening and channel. Adjust if necessary. Lubricate all moving parts. Check all channels for worn places and replace if necessary.)

GLASS
UNIT IV

JOB SHEET #4--REMOVE AND REPLACE A REAR TAILGATE GLASS

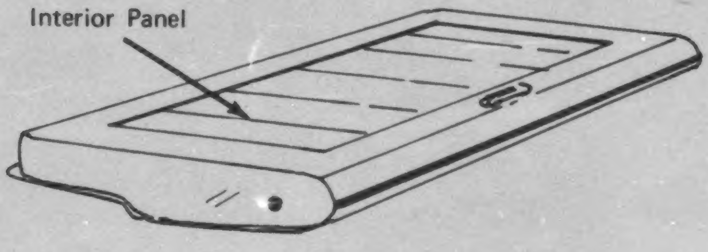
I. Tools and materials needed

- A. Wrenches 1/4"-5/8"
- B. Adjustable wrench 10"
- C. 1/4" drive socket set
- D. 3/8" drive socket set
- E. Phillips screwdriver set
- F. Straight blade screwdriver set
- G. Door handle remover tools
- H. Trim pad remover tools
- I. Hex wrench set
- J. Weather strip adhesive
- K. Trim adhesive
- L. Lubricant (oil, grease)
- M. Awl
- N. Glass puller
- O. Glass vise

II. Procedure

- A. Remove panel from tailgate (Figure 1)

FIGURE 1



JOB SHEET #4

B. Remove glass stops from tailgate, sash channel, and tailgate panel

C. Disconnect tailgate glass from regulator

   1. Remove cam rollers

   2. Remove bolts and nylon bushings

D. Remove glass from tailgate

   (NOTE: Slide glass out tailgate opening.)

E. Remove sash channel from glass using necessary method

   1. Use glass puller method

   2. Use hammer method

      (NOTE: Be careful not to bend or spring sash channel.)

      (CAUTION: Always protect hands and eyes when working with glass.)

F. Install sash channel on new glass

   (NOTE: Use a glass vise, if available, to hold glass. Drive sash channel on glass with a soft rubber mallot. Use the same thickness of glass tape as was used on the original glass.)

G. Trim off excess tape from glass

H. Replace glass in door (Reverse steps D thru A)

   (NOTE: Always be sure glass raises and lowers properly. Adjust if necessary. Lubricate all moving parts and replace all worn glass run channels. On some models, the glass raises into the top. Consult manufacturer's service manual for installation procedures.)

GLASS
UNIT IV

JOB SHEET #5--REMOVE AND REPLACE A GASKET TYPE WINDSHIELD OR BACK GLASS

I. Tools and materials needed

   A. Wrenches 1/4"-5/8"

   B. Adjustable wrench 10"

   C. 1/4" drive socket set

   D. 3/8" drive socket set

   E. Phillips screwdriver set

   F. Straight blade screwdriver set

   G. Door handle remover tools

   H. Trim pad remover tools

   I. Hex wrench set

   J. Weather strip adhesive

   K. Trim adhesive

   L. Lubricant (oil, grease)

   M. Awl

   N. Glass puller

   O. Glass vise

II. Procedure

   (NOTE: Some reveal moldings must be removed with the glass and are retained by the gasket. Check each molding carefully and determine method of installation before attempting removal.)

   A. Cover hood or deck area with protective cover

   B. Remove all interior trim as necessary

      1. Garnish moldings

      2. Rear view mirror

      3. Sun visors

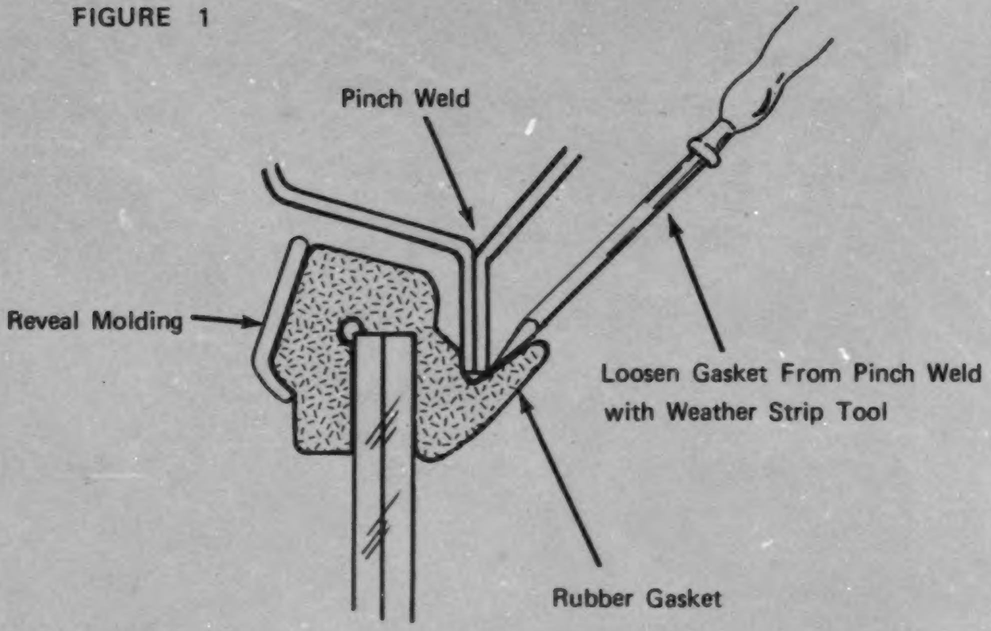
JOB SHEET #5

C. Remove all exterior moldings and trim

   1. Reveal moldings
   2. Cowl vent cover
   3. Windshield wipers

D. Loosen gasket from pinch weld (Figure 1)

FIGURE 1


Pinch Weld
Reveal Molding
Loosen Gasket From Pinch Weld with Weather Strip Tool
Rubber Gasket

E. Remove glass

(NOTE: Use hands or feet and push out slowly. Do not apply pressure which would break or shatter the glass. Check with your instructor.)

(CAUTION: Always wear gloves and high top boots for this step.)

F. Remove gasket from broken glass (Figure 2)

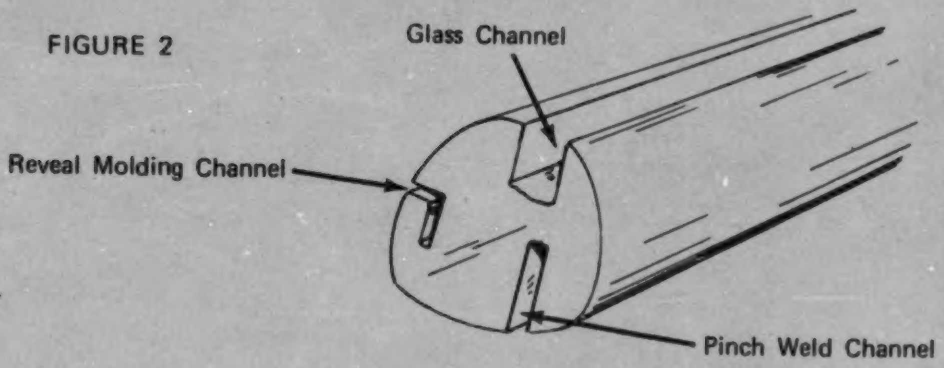
   1. Clean gasket where glass is installed
   2. Clean gasket where reveal molding is installed

JOB SHEET #5

3. Clean gasket where pinch weld fits (Figure 2)

   (NOTE: The gasket must be cleaned carefully. Any traces of glass or dirt in channel will result in breaking the new glass if not cleaned properly.)

FIGURE 2


Glass Channel
Reveal Molding Channel
Pinch Weld Channel

G. Install gasket on new glass

H. Install molding in molding channel of gasket

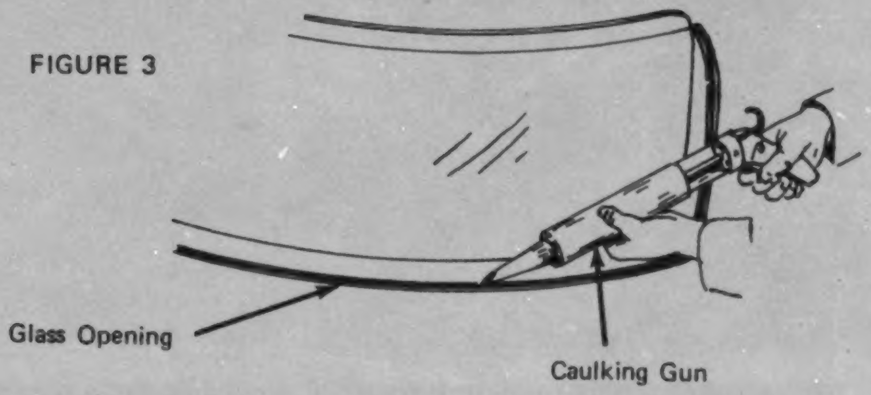
   (NOTE: See Figure 2.)

I. Soap outside of gasket

J. Place glass with gasket installed in glass opening of car

   (NOTE: If string pull method is used, install string in pinch weld channel before setting glass in glass opening. Always caulk around body opening before setting glass.) (Figure 3)

FIGURE 3


Glass Opening
Caulking Gun

JOB SHEET #5

K. Pull pinch weld channel lip over body pinch weld

(NOTE: See Figure 2.)

1. Pull string around opening
2. Pull lip using weather strip inserting tool

   (NOTE: See Figure 1.)

L. Slap glass with open palm of hand to insure proper seat in opening

(NOTE: Remove all rings before slapping glass.)

M. Install exterior moldings, trim, and windshield wipers

(NOTE: If moldings and trim bolt on, seal all holes and do not tighten too tight.)

N. Install interior moldings, trim, visors, etc.

(NOTE: Snug tighten only. If screws and bolts are tightened too tight, windshield may be broken.)

O. Seal glass between glass and channel

(NOTE: Use the proper sealing gun to seal to prevent glass breakage.)

P. Clean up

1. Clean all excess sealer from glass, car body, molding, and trim with approved cleaner
2. Clean glass with water
3. Be sure windshield wipers work properly

   (NOTE: Windshield and back glass installation is tedious work. Be sure your instructor is present during the glass installation.)

GLASS
UNIT IV

JOB SHEET #6--REMOVE AND REPLACE A GASKETLESS TYPE WINDSHIELD OR BACK GLASS

I. Tools and materials needed

- A. Wrenches 1/4"-5/8"
- B. Adjustable wrench 10"
- C. 1/4" drive socket set
- D. 3/8" drive socket set
- E. Phillips screwdriver set
- F. Straight blade screwdriver set
- G. Door handle remover tools
- H. Trim pad remover tools
- I. Hex wrench set
- J. Weather strip adhesive
- K. Trim adhesive
- L. Lubricant (oil, grease)
- M. Awl
- N. Glass puller
- O. Glass vise

II. Procedure

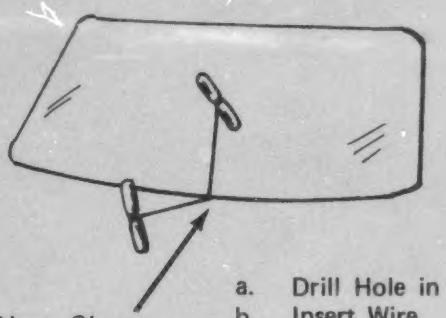
- A. Cover hood or deck area with protective cover
- B. Remove all interior trim as necessary
- C. Remove exterior moldings and trim
  - 1. Reveal moldings
  - 2. Cowl vent cover
  - 3. Windshield wipers

JOB SHEET #6

D. Cut glass from body

1. Piano wire method (Figure 1)

FIGURE 1



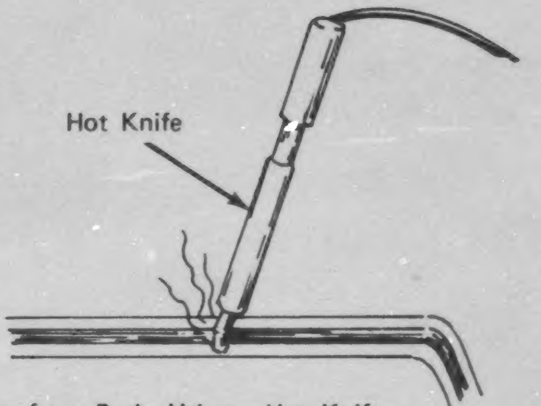
PIANO WIRE METHOD

Pull Wire Along Glass

a. Drill Hole in Caulking
b. Insert Wire
c. Cut by Pulling Wire Along Glass

2. Knife method (Figure 2)

FIGURE 2



Hot Knife

KNIFE METHOD

Cut Glass Free from Body Using a Hot Knife

E. Prep edge of glass with cleaner

F. Check and clean glass opening

G. Repair any bad places in caulking

(NOTE: In case of butyl, replace with a new kit.)

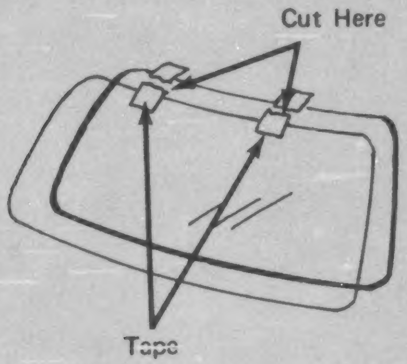
H. Lay bead of caulking on glass

JOB SHEET #6

I. Set glass in opening

(NOTE: To insure that glass is centered, set glass in opening before applying caulking and tape to car. Cut tape and leave section on car and glass. This will provide a center guide for placement.) (Figure 3)

FIGURE 3



J. Check for water leaks and repair as necessary

K. Clean excess caulking from glass

L. Install all molding and trim (Reverse steps B and C)

M. Clean up glass

(NOTE: Always leave side windows open to allow air to escape from passager compartment when doors are closed to prevent seal damage to glass.)

GLASS
UNIT IV

TEST

1. Match the following terms with the correct definition.

_____a. Channel in which the glass runs between the top and side of the door to prevent breakage

_____b. Channel between the door glass and vent glass

_____c. Small vent (wing) glass that opens and shuts to allow a vacuum and air circulation with the door glass up

_____d. Mechanical device, hand or motor operated, used to raise or lower door glass or to open and close vent glass

_____e. Channel used to fasten the door glass to the regulator

_____f. Rollers which operate in the sash channel and in other channels allowing the glass to be raised or lowered

1. Regulator
2. Cam
3. Glass-run channel
4. Ventilator
5. Sash channel
6. Center division channel

2. List two reasons for adjusting windows.

a.

b.

3. Describe the problem that usually exists when a window is stuck and will not raise or lower.

4. Describe the three ways door glass is held to the door regulator.

a.

b.

c.

5. Name the two types of glass used for doors.

   a.

   b.

6. Describe two methods for installing a gasket type windshield or back glass.

   a.

   b.

7. Describe two methods for removing a butyl or acrylic caulking installed windshield.

   a.

   b.

8. Demonstrate the ability to:

   a. Remove and replace a vent glass.

   b. Remove and replace a door glass with a vent glass.

   c. Remove and replace a door glass without a vent glass.

   d. Remove and replace a rear tailgate glass.

   e. Remove and replace a gasket type windshield or back glass.

   f. Remove and replace a gasketless type windshield or back glass.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

GLASS
UNIT IV

ANSWERS TO TEST

1. a. 3
   b. 6
   c. 4
   d. 1
   e. 5
   f. 2

2. a. Fits the window to the door for weather protection
   b. Allows the window to open and close with minimal effort

3. The window regulator pivot channel is out of adjustment

4. Description should include:
   a. Cam rollers with retaining clips
   b. Retaining shoulder type bolts with plastic bushings
   c. Sash channel bonded to glass

5. a. Laminated vinyl safety glass
   b. Tempered safety plate

6. Description should include:
   a. Drawstring method
   b. Weather strip inserting tool

7. Description should include:
   a. Cutting with piano wire
   b. Cutting with hot or cold knife

8. Performance skills will be evaluated according to the criteria listed on the progress chart.

FASTENERS
UNIT V

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms associated with fasteners to a list of definitions and identify the types of fasteners. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with fasteners to a list of definitions.
2. Identify the types of bolts.
3. Identify the types of screws.
4. Identify the types of washers.
5. Identify the types of nuts.
6. Identify the types of speed nuts.
7. Identify the types of rivets.

FASTENERS
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information sheet.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Give test.

II. Students:

  A. Read objective sheet.

  B. Study information sheet.

  C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency masters

    1. TM 1--Bolts

    2. TM 2--Screws

    3. TM 3--Washers and Pipe Thread

    4. TM 4--Nuts and Speed Nuts

    5. TM 5--Speed Nuts

    6. TM 6--Rivets

- D. Test
- E. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Co., 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

D. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

FASTENERS
UNIT V

INFORMATION SHEET

I. Terms and definitions

  A. UNC--Unified National Coarse

  B. USS--United States Standard

  C. UNF--Unified National Fine

  D. SAE--Society of Automotive Engineers

  E. Coarse thread--UNC or USS threads are used on bolts and nuts of soft and crumbly metals

  F. Fine thread--All UNF or SAE bolts and nuts are used where greater strength and additional accuracy of assembly are required

  G. Pipe thread--Tapered thread used on pipe tightened together to form a leakproof joint without using a gasket

  (NOTE: In some instances, pipe may be threaded with machine thread.)

  H. Straight drive--Any bolt using a straight blade screwdriver

  I. Phillips drive--Any bolt using a phillips blade screwdriver

  J. Self-tapping thread--Bolt so designed and with the hardness to make or cut its own threads in a drilled hole

  K. Unified--Threads conform to the standardization set by the United States and the United Kingdom

  L. Grade--Hardness of bolts determined by the marks on the bolt head; the greater number of marks, the harder the bolt

  M. Self-locking nut--Nut designed to self-lock to a bolt

II. Types of bolts (Transparency 1)

  A. Cap screw

  B. Bolt and nut

  C. Carriage bolt

  D. Bumper bolt

  E. Stud

INFORMATION SHEET

- F. Machine bolt
- G. Stove bolt

III. Types of screws (Transparency 2)

- A. Oval
- B. Round
- C. Flat
- D. Binding
- E. Fillister
- F. Truss
- G. Hexagon
- H. Hexagon slot
- I. Round sheet metal
- J. Flat sheet metal
- K. Oval sheet metal
- L. Pan sheet metal
- M. Truss sheet metal
- N. Hexagon sheet metal

IV. Types of washers (Transparency 3)

- A. Flat
- B. Fender
- C. Countersunk
- D. Spring lock
- E. Internal shakeproof
- F. External shakeproof
- G. Body

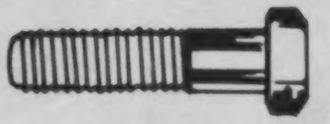
INFORMATION SHEET

V. Types of nuts (Transparency 4)
   A. Castle (Castellated)
   B. Acorn
   C. Square
   D. Hex
   E. Slotted hex
   F. Retainer
   G. Flanged hex nut

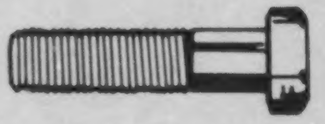
VI. Types of speed nuts (Transparencies 4 and 5)
   A. Flat
   B. J type
   C. U type
   D. Push-on type
   E. Tubular-type

VII. Types of rivets (Transparency 6)
   A. Hollow (Pop)
   B. Split
   C. General purpose
   D. Countersunk
   E. Hollow
   F. Shoulder
   G. Plastic self-locking

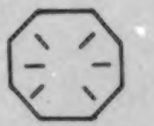
Bolts



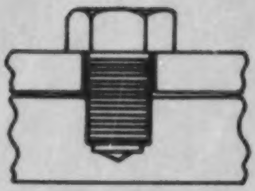
Coarse -Threaded Cap Screw



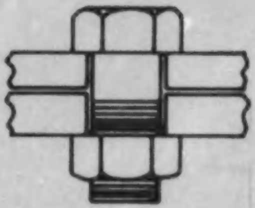
Fine- Threaded Cap Screw



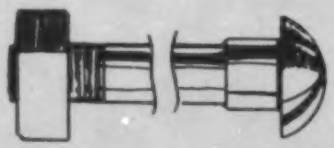
Bolt Grade 6



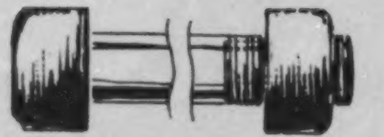
CAP SCREW



BOLT and NUT

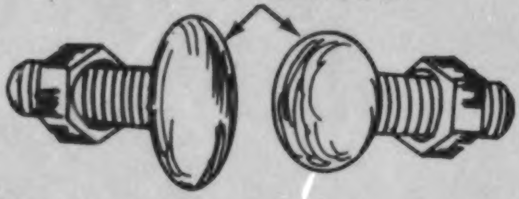


CARRIAGE BOLT



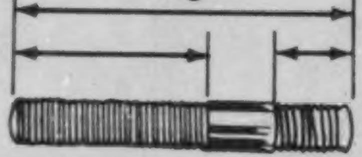
Square Head Square Nut

MACHINE BOLT



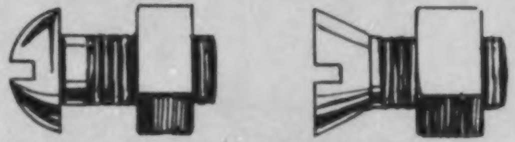
Elliptical Head Round Head

BUMPER BOLTS



Fine Thread Coarse Thread

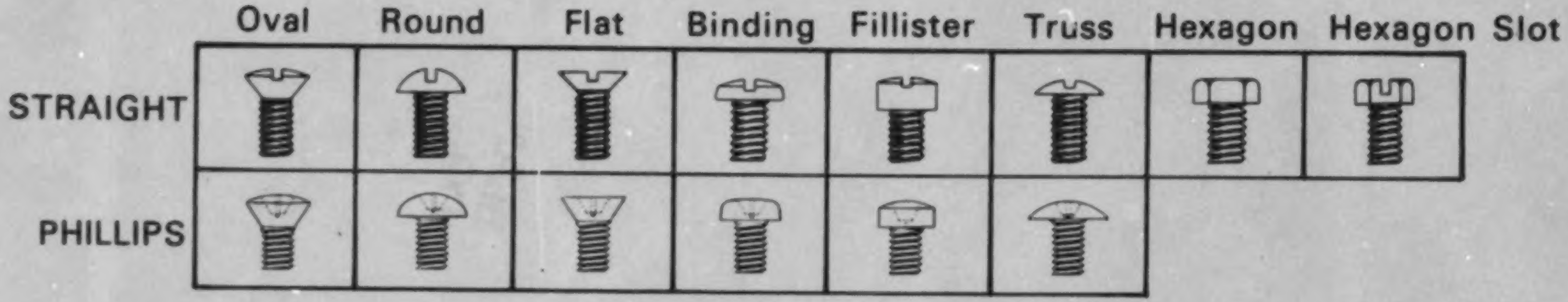
STUD



Round Flat

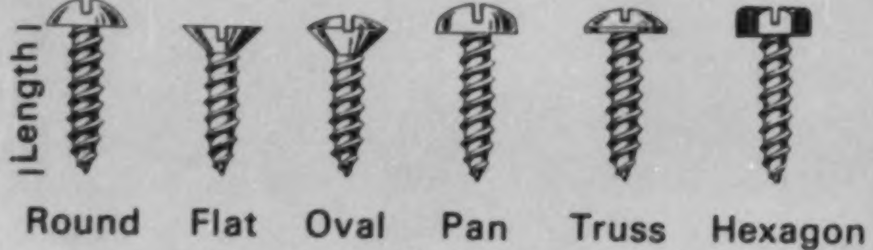
STOVE BOLTS

Screws

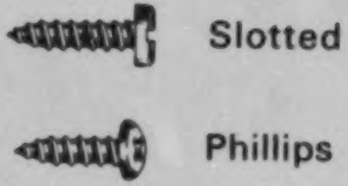

Oval
Round
Flat
Binding
Fillister
Truss
Hexagon
Hexagon Slot
STRAIGHT
PHILLIPS

MACHINE SCREWS

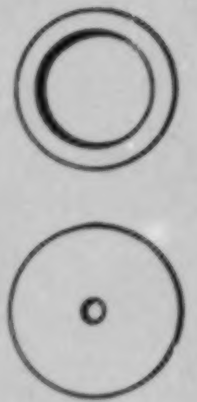
SHEET METAL SCREWS

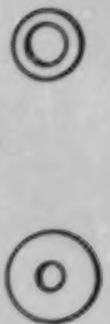

Length
Round
Flat
Oval
Pan
Truss
Hexagon

STRAIGHT BLADE or PHILLIPS


Slotted
Phillips

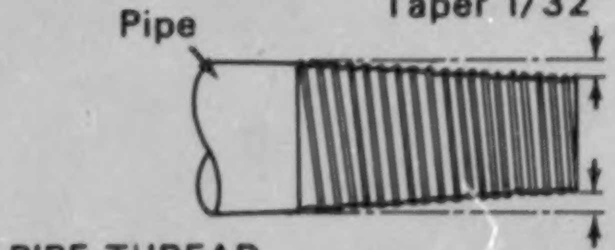
Washers and Pipe Thread





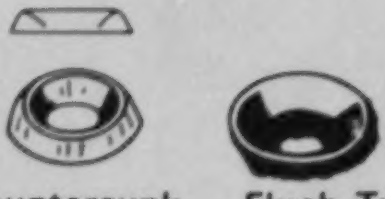
Flat Steel Washer

Fender Washer



Pipe
Taper 1/32'' per Inch
Taper 1/32'' per Inch

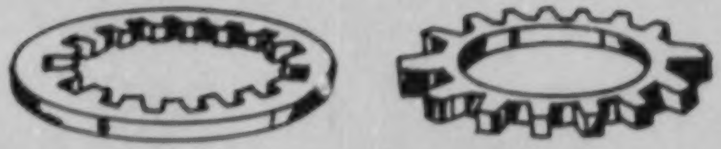
PIPE THREAD



Countersunk Type

Flush Type

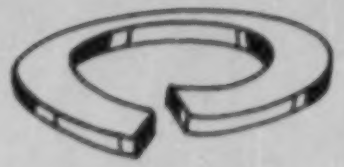
FINISHING (SCREW) WASHERS



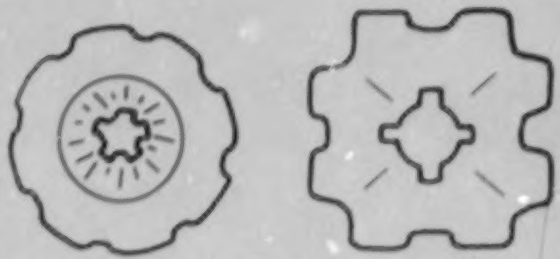
Internal Type

External Type

SHAKEPROOF LOCK WASHERS



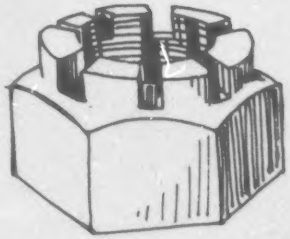
Spring Lock Washer

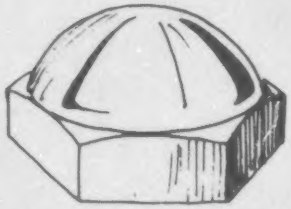


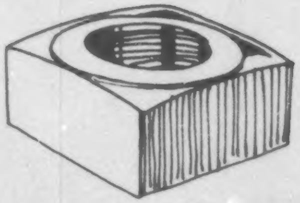
Body Washers

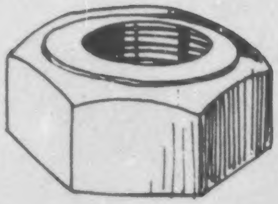
Nuts and Speed Nuts

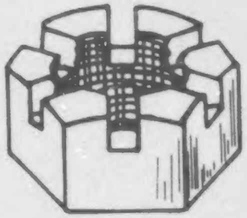
COMMON NUTS

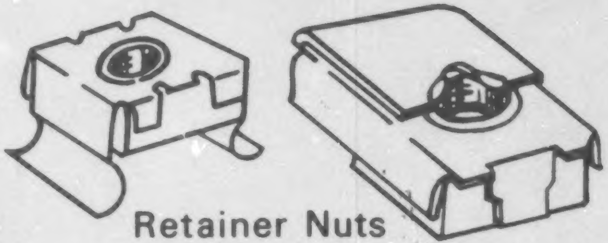

Castle (Castellated)

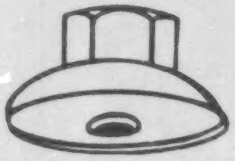

Acorn


Square

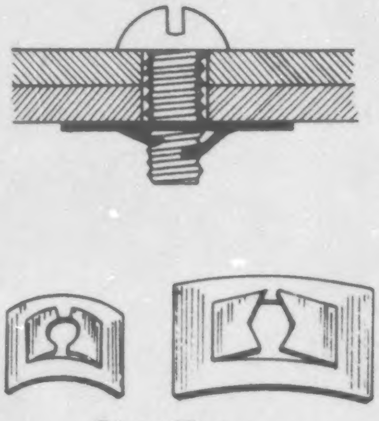

Hex

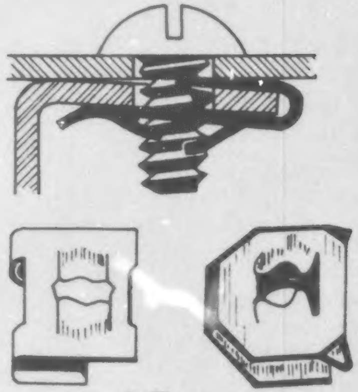

Slotted Hex

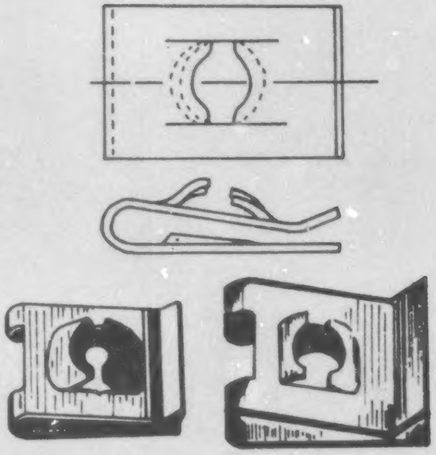

Retainer Nuts


Flanged Hex

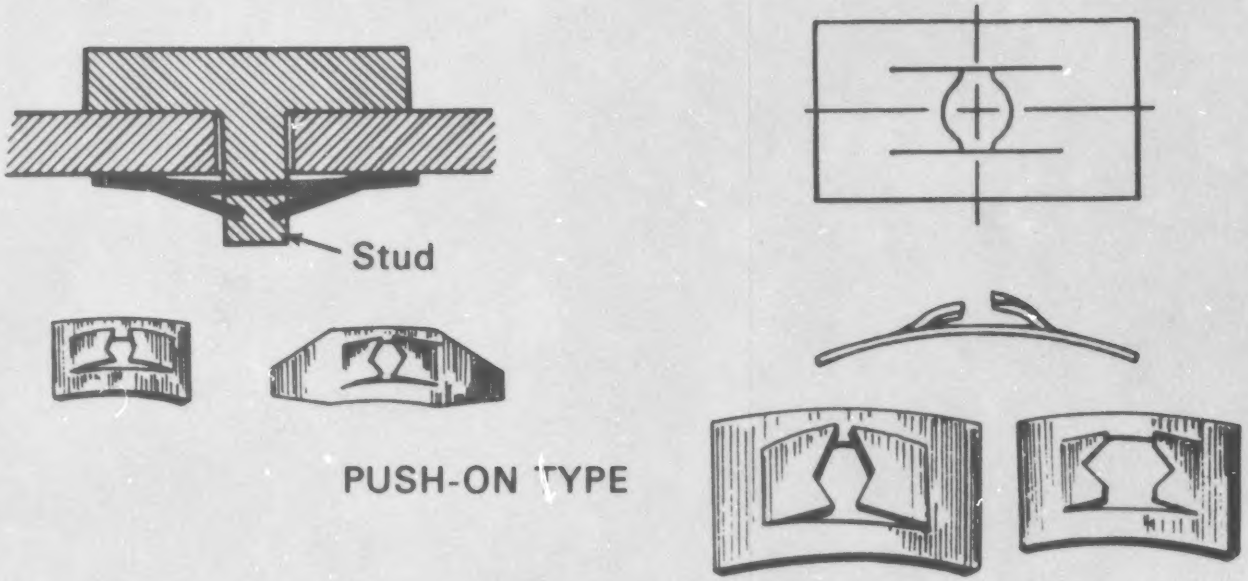
SPEED NUTS


Flat Type

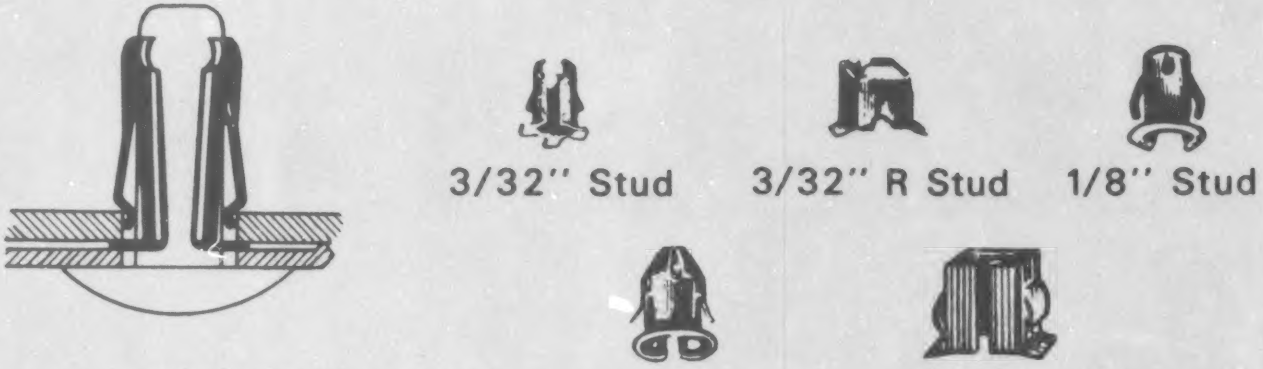

J Type


U Type

Speed Nuts



PUSH-ON TYPE



3/32'' Stud

3/32'' R Stud

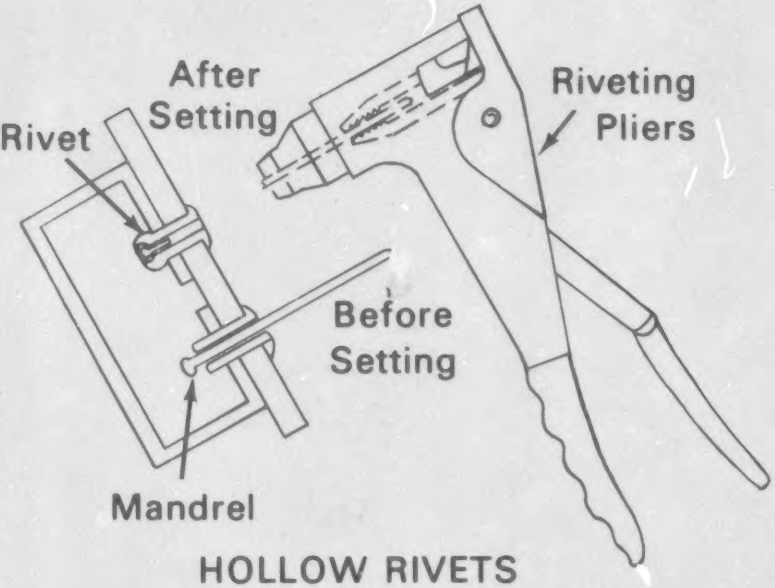
1/8'' Stud

1/8'' Stud

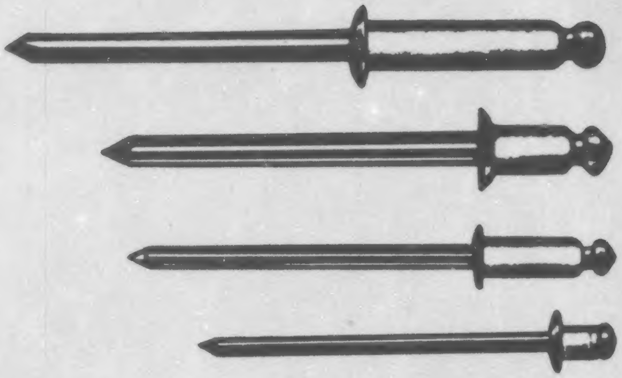
9/64'' R Stud

TUBULAR-TYPE SPEED CLIPS

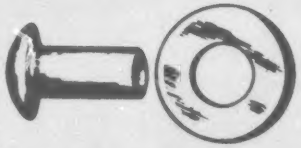
Rivets


After Setting
Rivet
Riveting Pliers
Before Setting
Mandrel

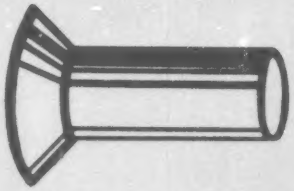
HOLLOW RIVETS



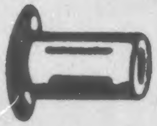
DIFFERENT SIZE "POP" RIVETS



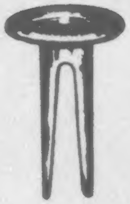
General Purpose Rivet



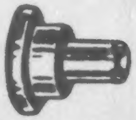
Countersunk Rivet



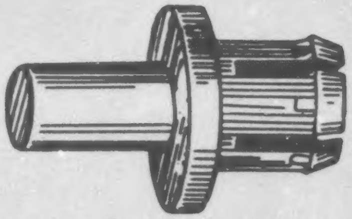
Hollow Rivet



Split Rivet



Shoulder Rivet



Plastic Self-Locking Rivet

FASTENERS
UNIT V

TEST

1. Match the following terms with the correct definition.

______a. Unified National Fine

______b. UNC or USS threads are used on bolts and nuts of soft and crumbly metals

______c. United States Standard

______d. Any bolt using a straight blade screwdriver

______e. Society of Automotive Engineers

______f. All UNF or SAE bolts and nuts are used where greater strength and additional accuracy of assembly are required

______g. Unified National Coarse

______h. Hardness of bolts determined by the marks on the bolt head; the greater number of marks, the harder the bolt

______i. Any bolt using a phillips blade screwdriver

______j. Threads conform to the standardization set by the United States and the United Kingdom

______k. Tapered thread used on pipe tightened together to form a leakproof joint without using a gasket

1. USS
2. Coarse thread
3. Phillips drive
4. Unified
5. SAE
6. Self-tapping thread
7. UNC
8. Pipe thread
9. Grade
10. Straight drive
11. UNF
12. Fine thread
13. Self-locking nut

_____l. Bolt so designed and with the hardness to make or cut its own threads in a drilled hole

_____m. Nut designed to self-lock to a bolt

2. Identify the types of bolts by placing the correct number in the blanks provided.

_____a. Cap screw

_____b. Bolt and nut

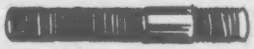
_____c. Carriage bolt

_____d. Bumper bolt

_____e. Stud

_____f. Machine bolt

_____g. Stove bolt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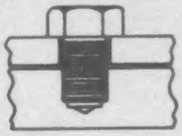
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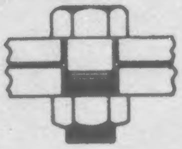
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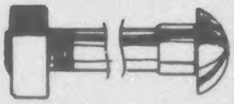
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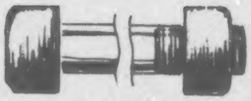
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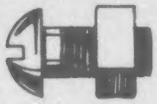
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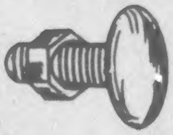

7.

3. Identify the types of screws by placing the correct number in the blanks provided.

______a. Oval

______b. Round

______c. Flat

______d. Binding

______e. Fillister

______f. Truss

______g. Hexagon

______h. Hexagon slot

______i. Round sheet metal

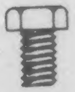
______j. Flat sheet metal

______k. Oval sheet metal

______l. Pan sheet metal

______m. Truss sheet metal

______n. Hexagon sheet metal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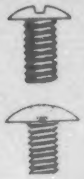
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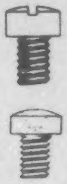
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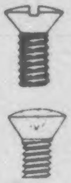
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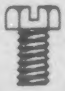
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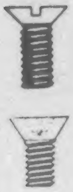
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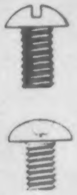
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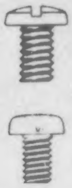
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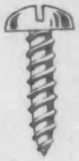
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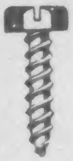
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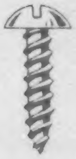
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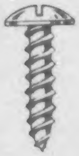
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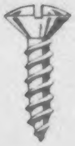
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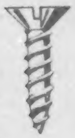

14.

4. Identify the types of washers by placing the correct number in the blanks provided.

______a. Flat

______b. Fender

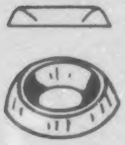
______c. Countersunk

______d. Spring lock

______e. Internal shakeproof

______f. External shakeproof

______g. Body



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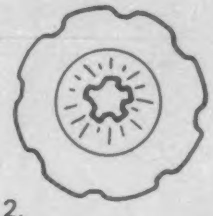

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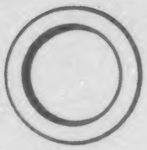

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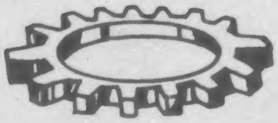

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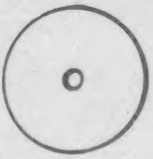

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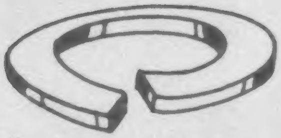

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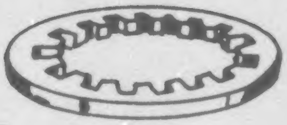


7.

5. Identify the types of nuts by placing the correct number in the blanks provided.

______a. Castle (Castellated)

______b. Acorn

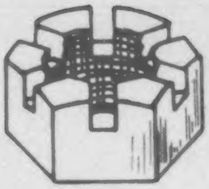
______c. Square

______d. Hex

______e. Slotted hex

______f. Retainer

______g. Flanged hex nut



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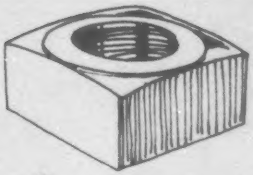

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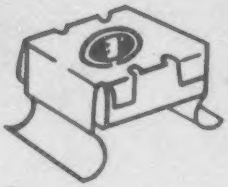

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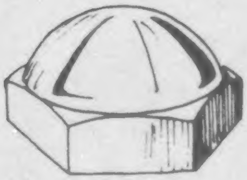

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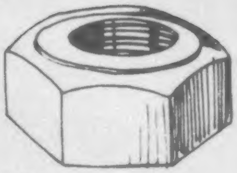

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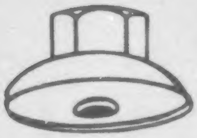

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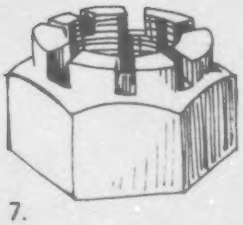


7.

6. Identify the types of speed nuts by placing the correct number in the blanks provided.

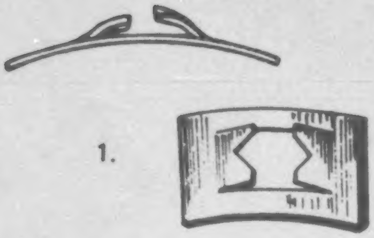
______a. Flat

______b. J type

______c. U type

______d. Push-on type

______e. Tubular-type



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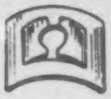

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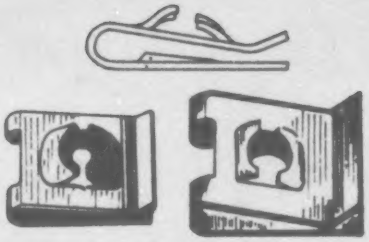

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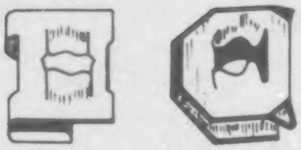

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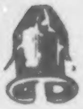


5.

7. Identify the types of rivets by placing the correct number in the blanks provided.

______a. Hollow (Pop)

______b. Split

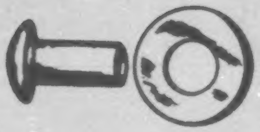
______c. General purpose

______d. Countersunk

______e. Hollow

______f. Shoulder

______g. Plastic self-locking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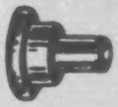
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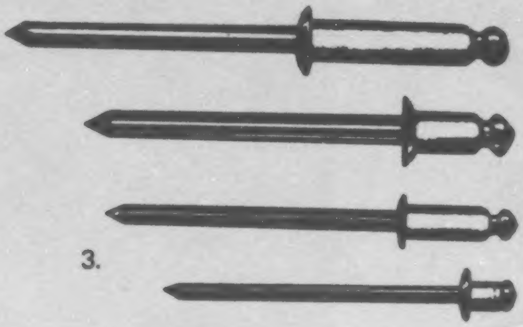
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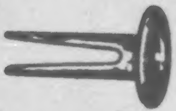
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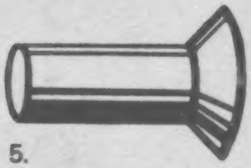
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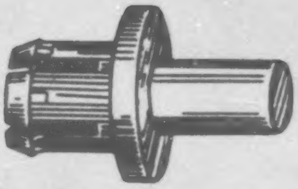
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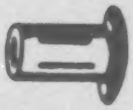
7.

FASTENERS
UNIT V

ANSWERS TO TEST

1. a. 11
b. 2
c. 1
d. 10
e. 5
f. 12
g. 7
h. 9
i. 3
j. 4
k. 8
l. 6
m. 13

2. a. 2
b. 3
c. 4
d. 7
e. 1
f. 5
g. 6

3. a. 4
b. 7
c. 6
d. 8
e. 3
f. 2
g. 1
h. 5
i. 11
j. 14
k. 13
l. 9
m. 12
n. 10

4.	a.	3
	b.	5
	c.	1
	d.	6
	e.	7
	f.	4
	g.	2
5.	a.	7
	b.	4
	c.	2
	d.	5
	e.	1
	f.	3
	g.	6
6.	a.	2
	b.	3
	c.	4
	d.	1
	e.	5
7.	a.	3
	b.	4
	c.	1
	d.	5
	e.	7
	f.	2
	g.	6

Auto Body
PROGRESS CHART

Section G-1
Hardware, Glass, and Trim

	Unit I								Unit II								Unit III			
	Exterior Molding & Trim Fasteners								Interior Trim								Hardware			
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4
		Remove & Replace									Remove & Replace							Remove & Replace		
Job	Unit Test	Belt Moldings	Rocker Moldings	Wheel Opening Moldings	Reveal Moldings	Drip Rail Scalp Moldings	Script Nameplate Trim		Unit Test	Clip Attached Door Handle	Screw Attached Door Handle	Pin Attached Door Handle	Door Trim Panel	Seats	Drop and Install Headliner		Unit Test	Manual Window Regulator	Electric Window Regulator	Vent Window Assembly
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4
85% Correct																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
85% Correct																	
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See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
85% Correct																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	

Auto Body
PROGRESS CHART

Section G-2
Hardware, Glass, and Trim
(continued)

	Unit III Hardware (Continued)							Unit IV Glass								Unit V Fasteners				
	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	1	2			
	Remove & Replace								Remove and Replace											
Job	Inside Door Remote Control	Door Lock Cylinder	Door Latch	Outside Door Handle	Center Division Channel	Run Channel	Door Weather Strip	Unit Test	Vent Glass	Door Glass with a Vent Glass	Door Glass without a Vent Glass	Rear Tailgate Glass	Gasket Type Windshield or Back Glass	Gasketless Type Windshield or Back Glass		Unit Test				
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
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85% Correct																	

UNDER BODY MEASUREMENT
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms associated with under body measurement to a list of definitions, identify the types of frame damage, and name the methods of obtaining specifications for measurement. He should be able to use the self-centering gauge and tram gauge properly. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with under body measurement to a list of definitions.
2. Identify five conditions found in frame damage.
3. Name two methods of obtaining frame specifications for measurement.
4. Name the major points necessary for frame measurement.
5. Name the two measurements that can be performed at all major measuring points.
6. List the three measuring devices used in frame measurement.
7. List the three ways centering gauges are used.
8. Describe how to locate the center line using centering gauges.
9. Describe how the centering gauges should be hung from the frame rails.
10. List the three specifications that a body man must have to set up a tram gauge.
11. Describe how the tram gauge is set up.
12. List the sequence for repairing damaged frames.
13. Demonstrate the ability to:
    a. Use the self-centering gauge.
    b. Use the tram gauge.

UNDER BODY MEASUREMENT
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Datum and Center Lines

      2. TM 2--Types of Frame Damage

      3. TM 3--Types of Frame Damage (Continued)

      4. TM 4--Types of Frame Damage (Continued)

5. TM 5--Self-Centering Gauge
6. TM 6--Tram Gauge
7. TM 7--Alignment of Self-Centering Gauge
8. TM 8--Tram Gauge Specifications
9. TM 9--Setting Up a Tram Gauge

D. Job sheets

1. Job Sheet #1--Trouble Shooting Frame Damage Using the Self-Centering Gauge
2. Job Sheet #2--Using the Tram Gauge

E. Test

F. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Company of Canada Limited, 1969.

B. McPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Book Company Inc., 1971.

C. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

D. Toboldt, Bill. *Autobody Repairing and Repainting.* Third Edition. South Holland, Illinois: Goodheart-Willcox Company, Inc., 1972.

UNDER BODY MEASUREMENT
UNIT I

INFORMATION SHEET

I. Terms and definitions (Transparencies 1, 2, 3, 4, 5, 6, 7, 8, and 9)

   A. Datum line--Imaginary line which is parallel to the floor of the automobile from which dimensions are plotted

   B. Center line--Vertical line that cuts the car in half lengthwise

   C. Sag--Condition occurs where the center of the car is sagging

   D. Collapse--Front or rear of the car has collapsed down

   E. Twist--Condition occurs where the two frame rails are pointed in different directions instead of being parallel

   F. Mash--Damage is straight causing buckles to appear on rail sides on both the top and bottom of the rail, and on either side

   G. Diamond--Occurs where one rail is forward of the other; this damage can only be detected by use of tram gauges

   H. Sidesway--Condition occurs where rail or rails are shifted to right or left

   I. Self-centering gauge--Consists of a horizontal bar, two vertical bars, and a sighting pin; regardless of what position it is in, the center sight remains in its center position

   J. Tram gauge--Consists of a long adjustable bar and two upright adjustable pointers for measuring over obstructions

   K. Tracking--Determines whether the rear wheels follow the front wheels properly

II. Conditions found in frame damage

   A. Mash

   B. Sway

   C. Diamond

   D. Sag

   E. Twist

   (NOTE: In unit body construction, sag, diamond, and twist do not normally occur.)

INFORMATION SHEET

III. Methods for obtaining frame specifications
   - A. Frame dimension charts or books
   - B. Measuring and comparing damaged vehicle to an undamaged vehicle

IV. Major points necessary for frame measurement
   - A. Overall length
   - B. Width
   - C. Cross (diagonal) measurement
   - D. Location of
      1. Front suspension
      2. Rear suspension
      3. Steering gear
      4. Idler arm
      5. Transmission support
      6. Bumper attachment
      7. Body and fender mount holes

V. Two measurements that can be performed at all major measuring points
   - A. Distance from the next reference point
   - B. Distance to the datum line

VI. Measuring devices used in frame measurement
   - A. Tape measure
   - B. Tram gauge
   - C. Self-centering gauge

VII. Uses of centering gauges
   - A. To locate the center of the car
   - B. To detect any twist condition
   - C. To see the datum line

     (NOTE: Gauges must be set for the datum line according to dimension charts.)

INFORMATION SHEET

VIII. Location of center line (Transparency 10)--Use centering gauges and hang them from the frame using identical points on each side of the frame; the center shifting pins will line up with each other thus locating the center line

IX. Hanging centering gauges--This should be done from the frame rails using identical points on each side; some gauges have magnetic hangers eliminating the need to search for identical frame holes and braces

X. Three specifications needed to set up a tram gauge (Transparency 11)

  A. Height of the pointer at position A

  B. Height of the pointer at position B

  C. Distance between them as measured along the datum line

XI. Setting up the tram gauge (Transparency 12)--Accomplished by measurement; the pointers are adjustable for height and are set at distances derived, using frame dimension charts, from a point on the frame to the datum line; the length of the tram bar is set according to the distance between two designated points on the frame along the datum line

XII. Sequence for repairing damaged frames

  A. Correct the length

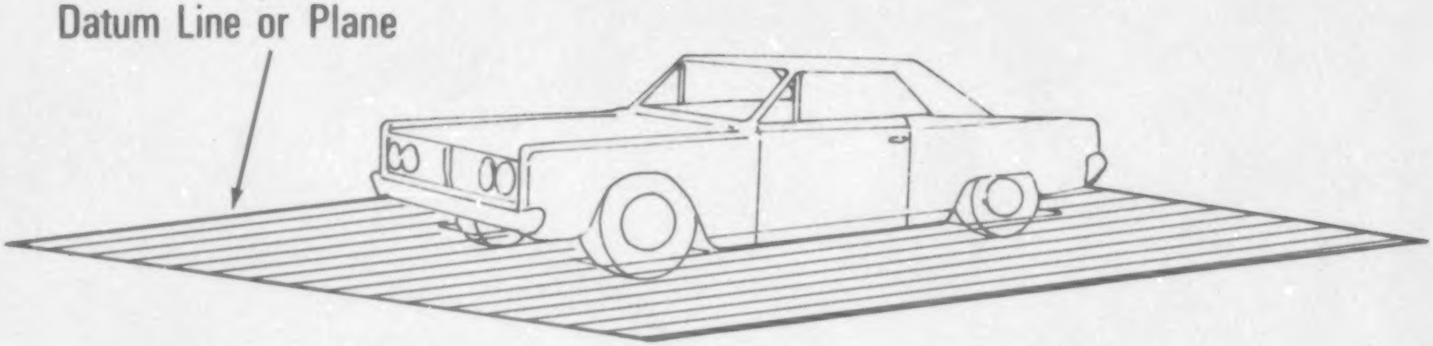
  B. Correct the width

  C. Correct the height

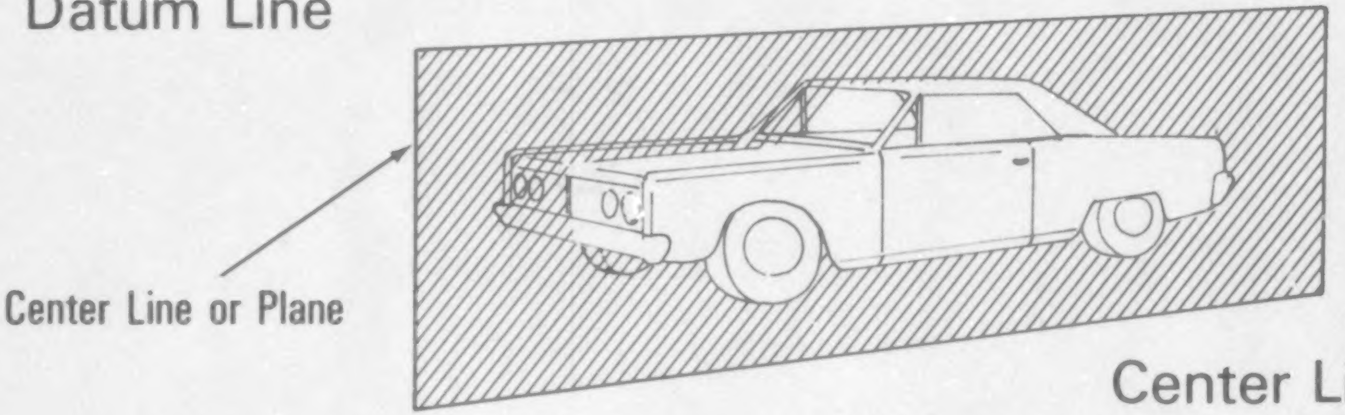
  D. Correct diamond condition

  E. Correct twist condition

Datum and Center Lines


Datum Line or Plane

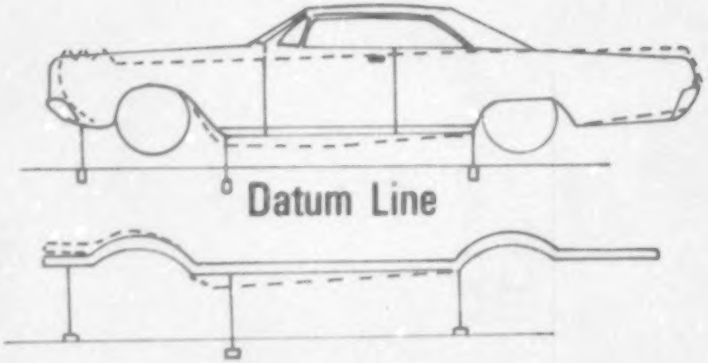
Datum Line


Center Line or Plane

Center Line

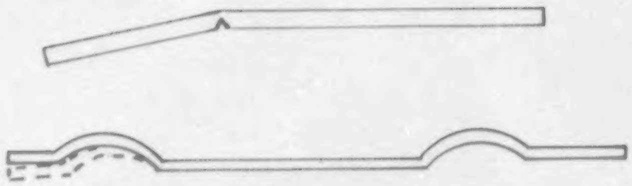
Types of Frame Damage

Sag



Sag-This condition occurs where the center of the car is sagging, not the front or rear. Analysis will tell you that the buckle must be on the top of the rail.

Collapse

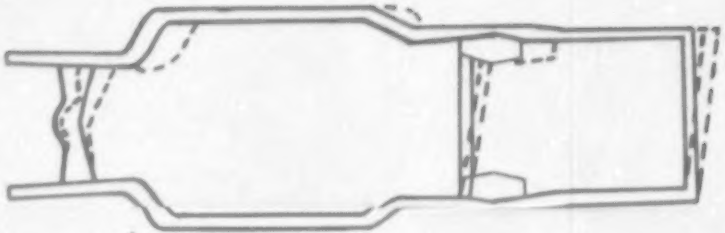


Collapse-This condition occurs where the front or rear of the car is collapsed or down. Analysis tells us that the buckle must be on the bottom of the rail.

Types of Frame Damage

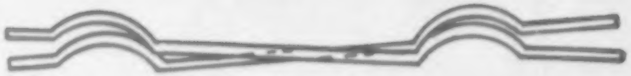
(Continued)

Diamond



Diamond-This condition occurs when one rail is forward of the other. It rarely occurs with X-member (or hourglass) frames. It can be detected only with the use of the tram gauges. The center gauges alone would show the center line in its proper position, regardless of the diamond condition being present.

Twist

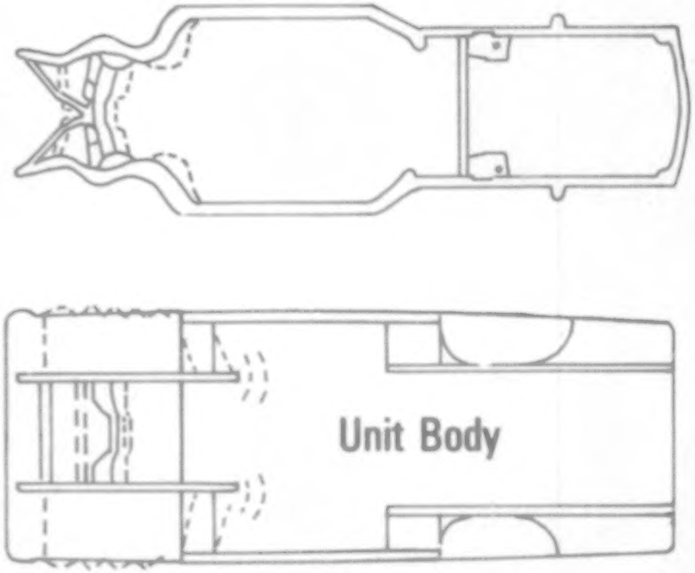


Twist-This condition occurs where the two rails are pointed in different directions (although perhaps straight) instead of being parallel as they should be. Twisted conditions occur with underbody damage like the damage occurring going over a high curb.

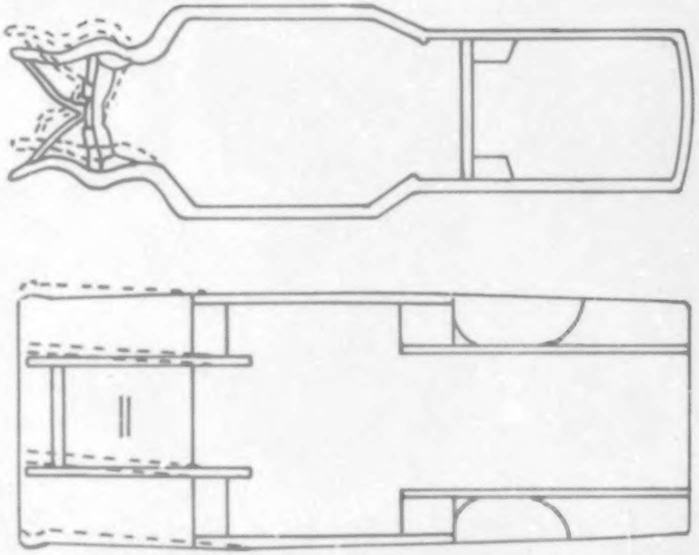
Types of Frame Damage

(Continued)

Mash



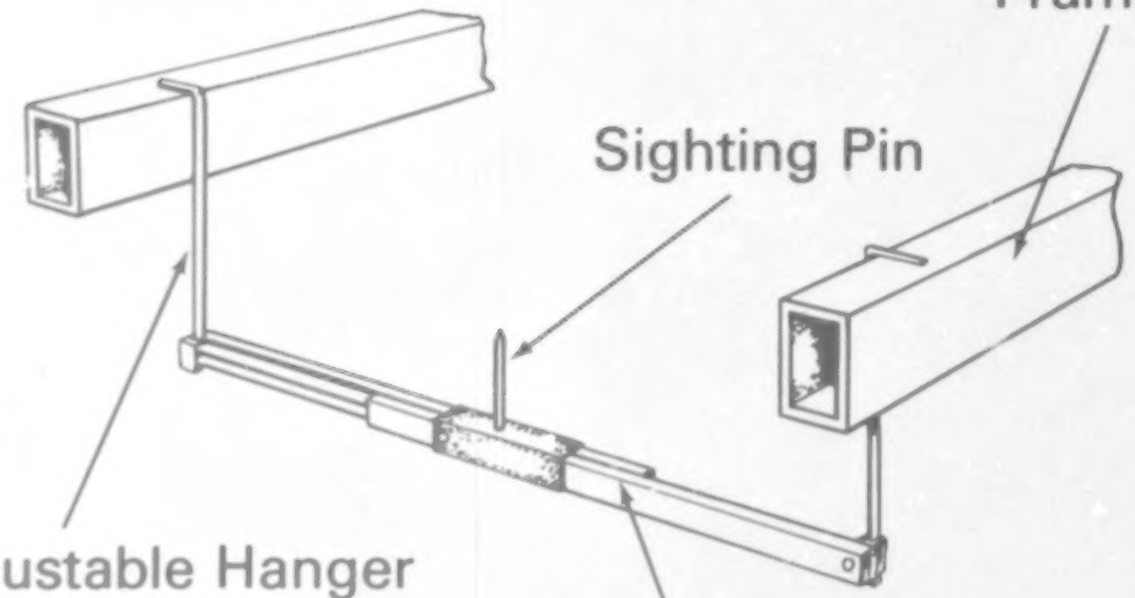
Sidesway



Mash-This condition occurs where the frame is damaged straight in, causing buckles to appear on both the top and bottom of the rail, and also on either side.

Sidesway-This condition occurs where the rail or rails are shifted to the right or left. Sidesway is present when the buckles are on one side of the rail.

Self-Centering Gauge



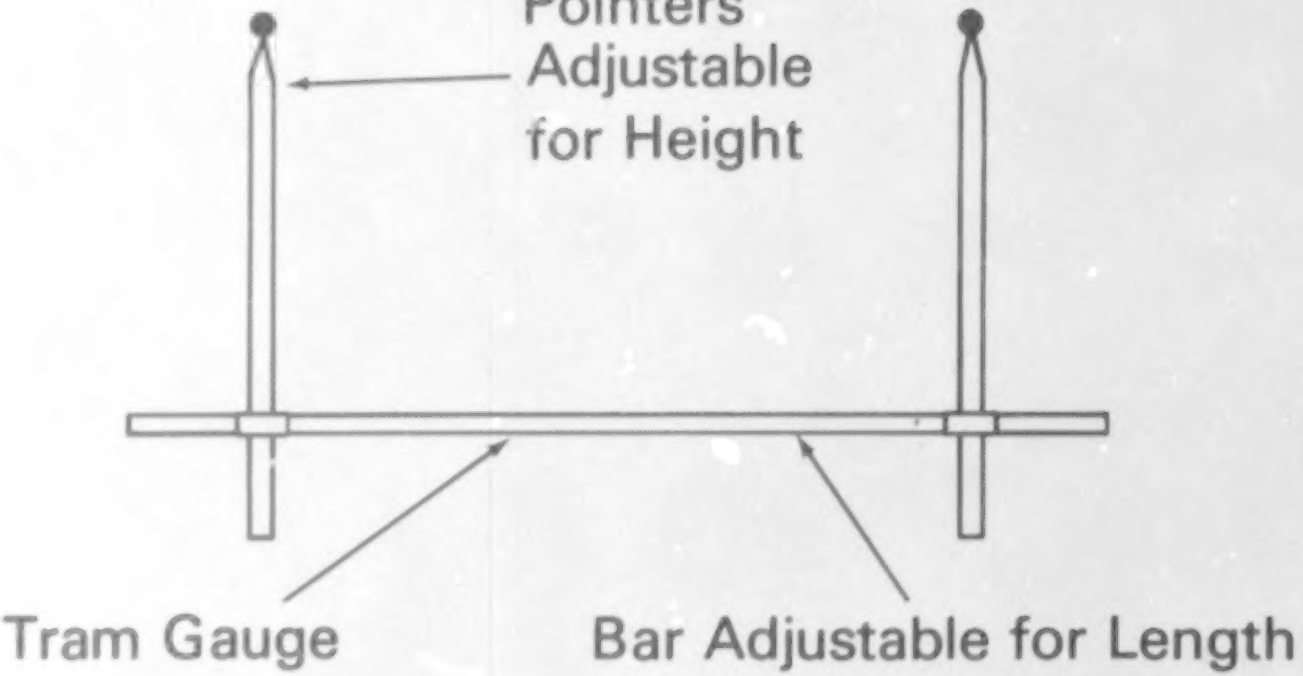
Frame Rail

Sighting Pin

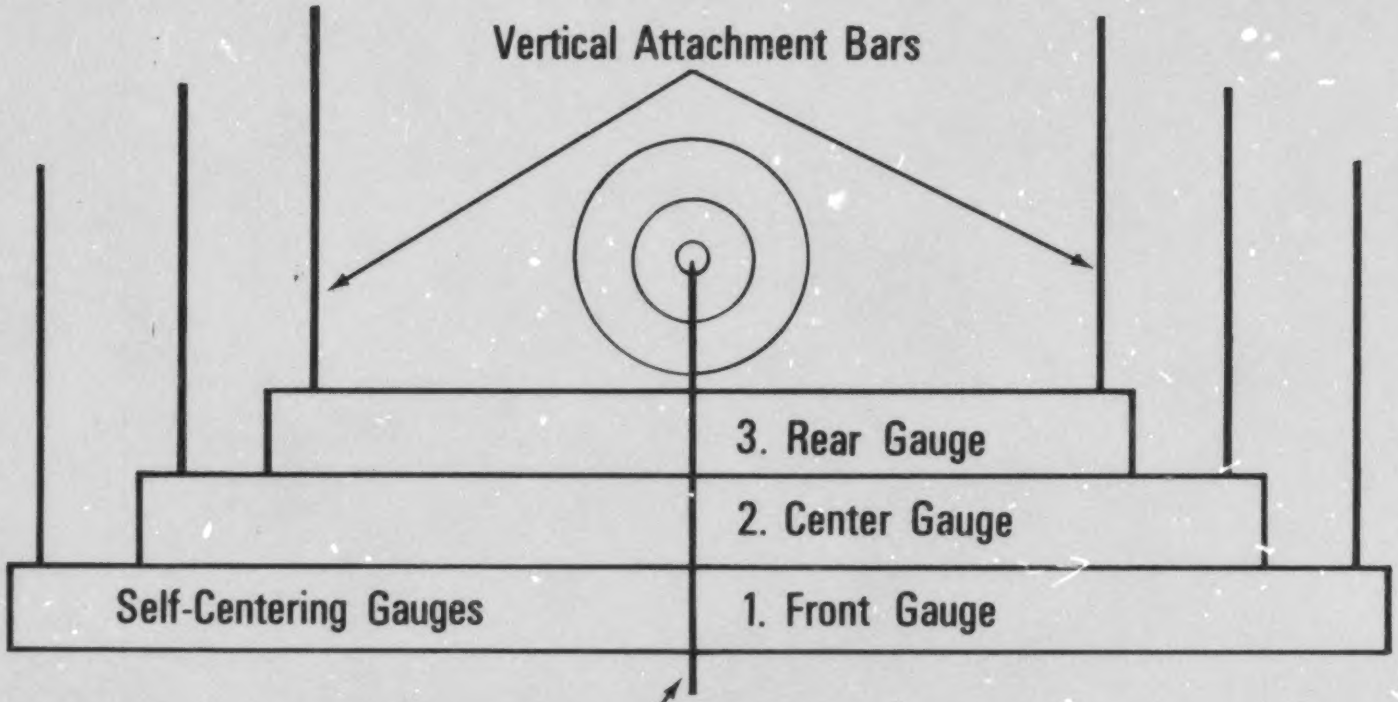
Adjustable Hanger

Gauge Self-Centering for Width

Tram Gauge

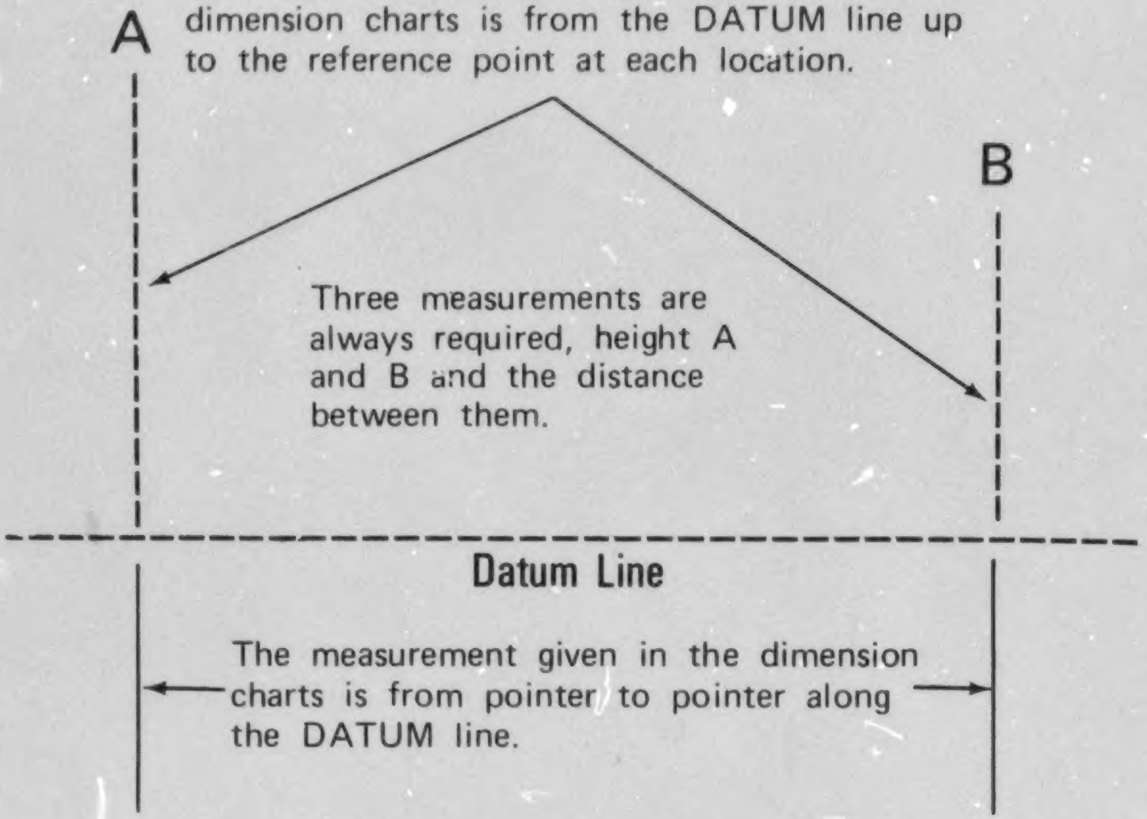

Pointers
Adjustable
for Height
Tram Gauge
Bar Adjustable for Length

Alignment of a Self-Centering Gauge


Vertical Attachment Bars
3. Rear Gauge
2. Center Gauge
Self-Centering Gauges
1. Front Gauge

Sight pins line up with each other thus center line is established.

Tram Gauge Specifications

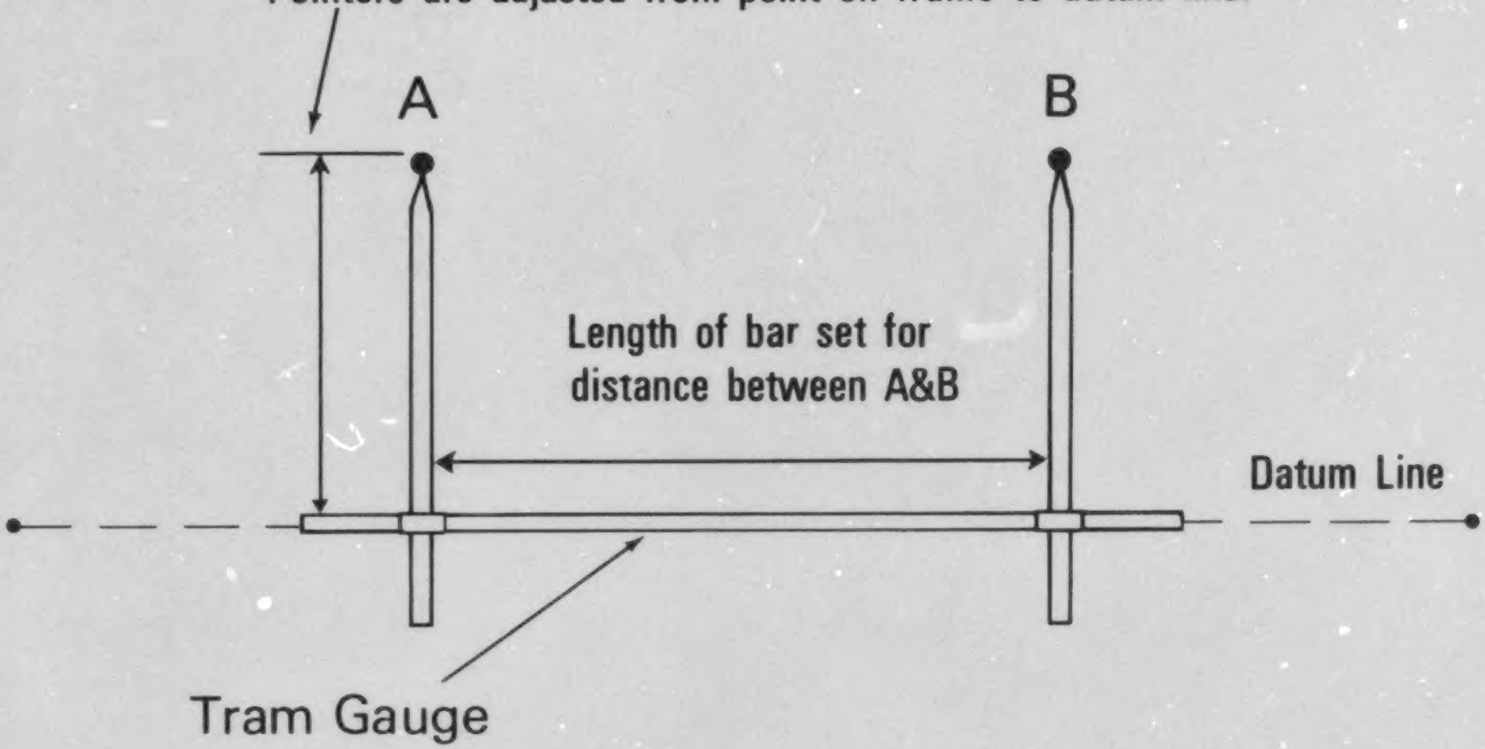


The measurement given for height in the dimension charts is from the DATUM line up to the reference point at each location.

Three measurements are always required, height A and B and the distance between them.

The measurement given in the dimension charts is from pointer to pointer along the DATUM line.

Setting Up A Tram Gauge



Pointers are adjusted from point on frame to datum line.

Length of bar set for distance between A&B

A
B
Datum Line
Tram Gauge

UNDER BODY MEASUREMENT
UNIT I

JOB SHEET #1--TROUBLE SHOOTING FRAME DAMAGE USING THE SELF-CENTERING GAUGE

I. Tools and equipment

  A. Set self-centering gauges

  B. Set of vertical bars for gauges

  C. Attaching pins and clamps

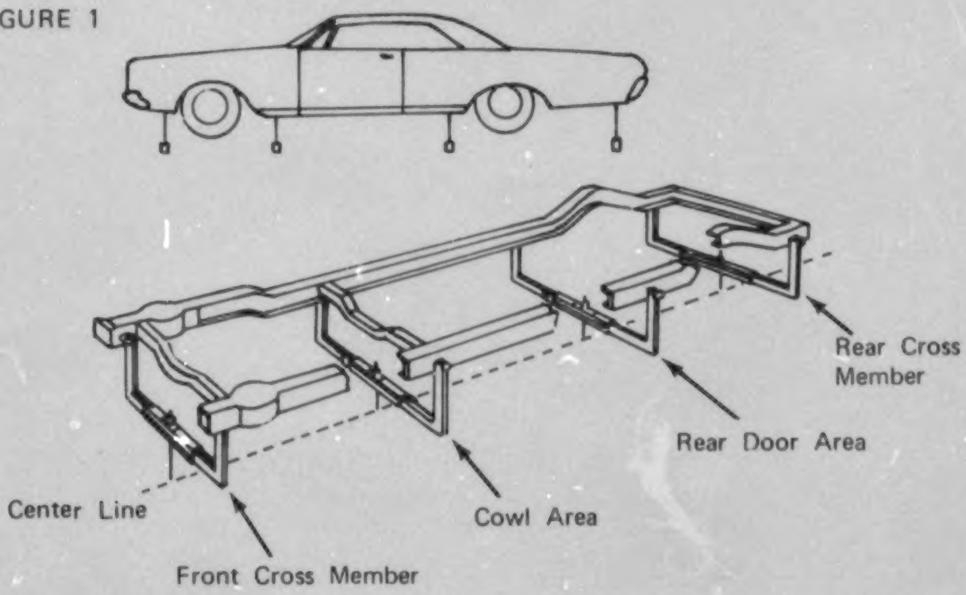
II. Procedure

  A. Jack car up and set on safty stands (Figure 1)

  (CAUTION: Set safty stands at predetermined places at equal heights to prevent the car from falling off stands.)

  B. Install gauges on frame

FIGURE 1

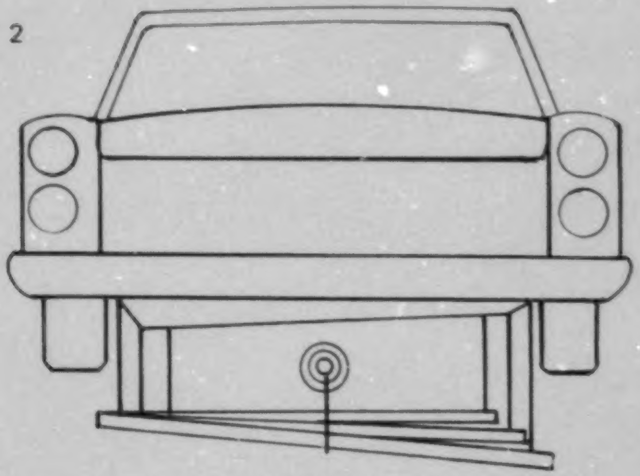

Rear Cross Member
Rear Door Area
Center Line
Cowl Area
Front Cross Member

(NOTE: If only three gauges are used, place one at the front end, on the floor, and at the rear end area.)

JOB SHEET #1

C. Check reading of gauges showing twist (Figure 2)

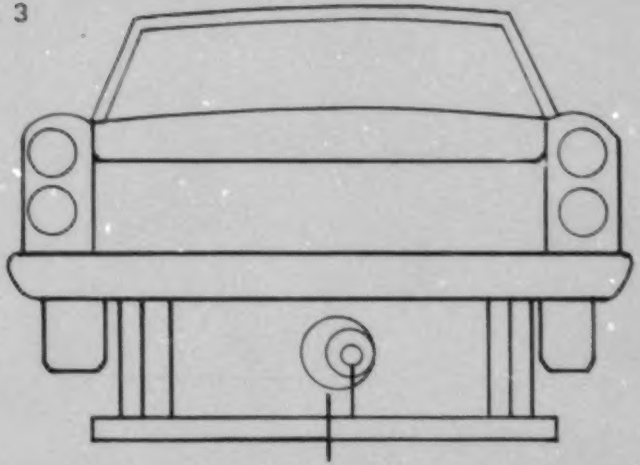
FIGURE 2



Center pins show vertical and horizontal alignment to be correct. Horizontal bars are tilted.

D. Check reading of gauges showing sway (Figure 3)

FIGURE 3

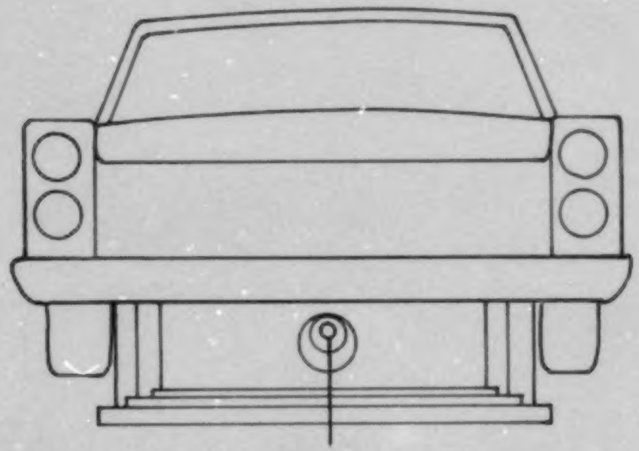


From this set of gauges we see sway to the right. Self centering bars should be in the same plane.

JOB SHEET #1

E. Check reading of gauges showing sag (Figure 4)

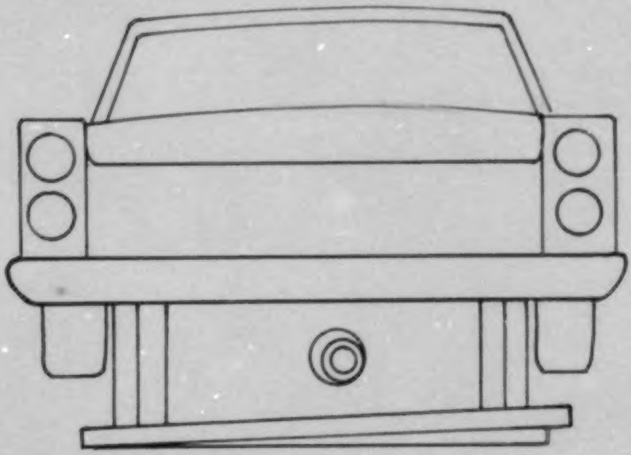
FIGURE 4



From this set of gauges we see front end sag.

F. Check reading of gauges showing mash (Figure 5)

FIGURE 5



From this set of gauges we see kick up. Sight pins are out of line to right and self centering bars are not parallel or horizontal.

JOB SHEET #1

G. Check frame for diamond condition using the diamond detector attachment (Figure 6)

Diamond Detector Attachment

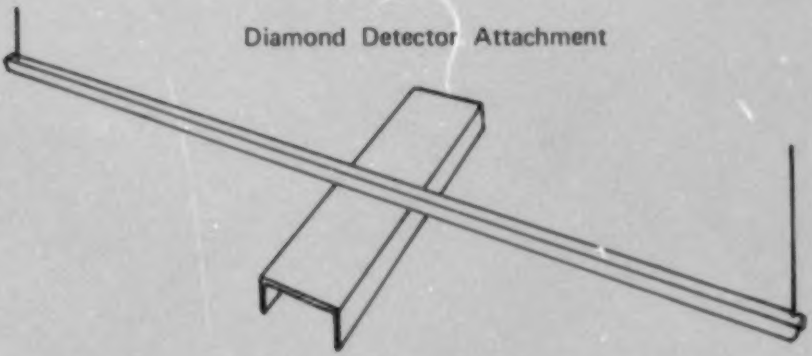
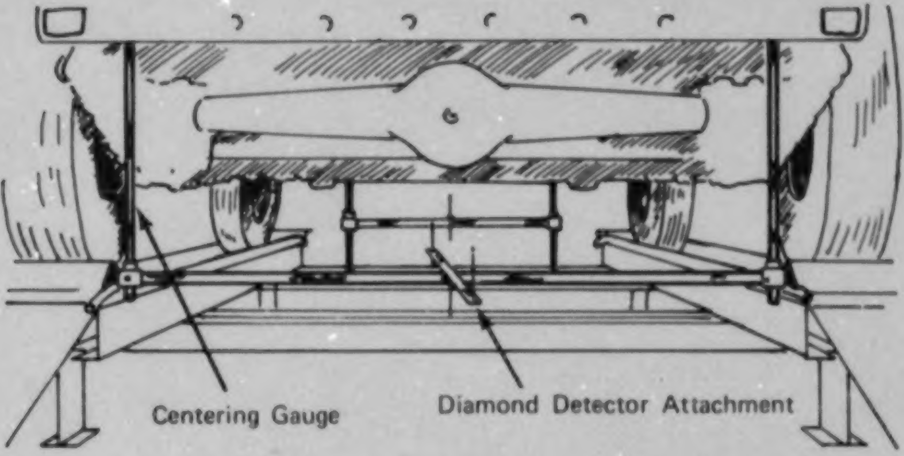


FIGURE 6


Centering Gauge
Diamond Detector Attachment

Using the Attachment
Checking for a Diamond Condition

UNDER BODY MEASUREMENT
UNIT I

JOB SHEET #2--USING THE TRAM GAUGE

I. Tools and equipment

   A. Tram gauge

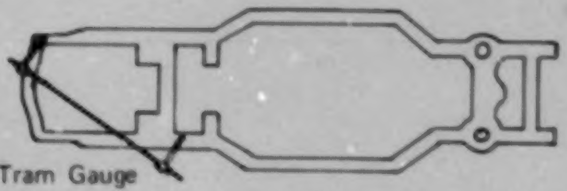
   B. Tape measure

   C. Frame dimension chart

II. Procedure

   A. Cross check any four points on a car frame (Figure 1)

FIGURE 1



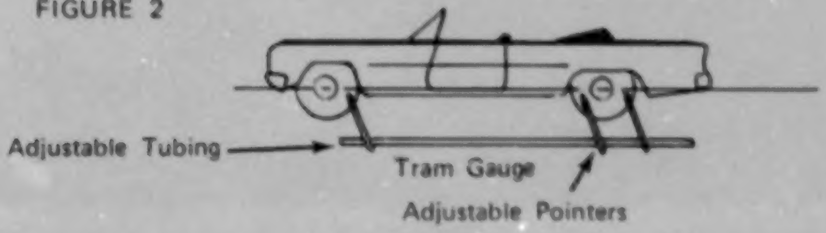
Using the tram gauge to check the end of a perimeter frame for square by diagonal measurement.

   B. Tram the deck lid, hood, windshield, and back glass openings

   (NOTE: Dimensions are not necessary, just use identical points on both sides and the diagonal measurement should be the same.)

   C. Tram the wheel base to check for tracking (Figure 2)

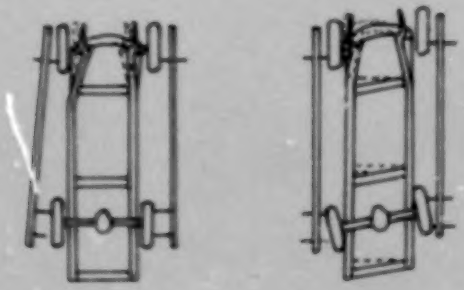
FIGURE 2


Adjustable Tubing
Tram Gauge
Adjustable Pointers

JOB SHEET #2

D. Tram the wheel base to check for frame misalignment (Figure 3)

FIGURE 3



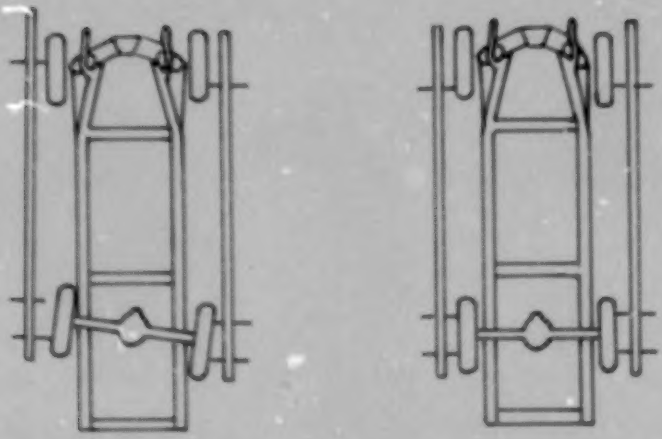
Swayed Frame Diamond Frame

Frame Misalignment Indications

(NOTE: Location of pointers and gauge angle indicates frame misalignment.)

E. Tram the wheel base to check for suspension misalignment (Figure 4)

FIGURE 4



Swung Rear End Suspension Back on Right Side

Suspension Misalignment Indications

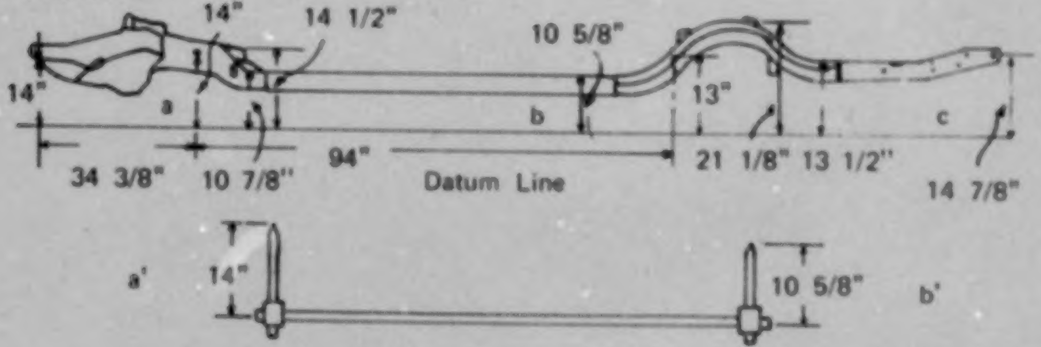
(NOTE: Location of pointers indicates suspension misalignment. Bar of gauge remains parallel from right to left.)

JOB SHEET #2

F. Set the tram gauge to dimensions of chart to show length of pointers (Figure 5)

All Dimensions to Holes are Measured to the Center of the Holes

FIGURE 5


14"
14 1/2"
10 5/8"
14"
a
b
13"
c
34 3/8"
10 7/8"
94"
Datum Line
21 1/8"
13 1/2"
14 7/8"
a'
14"
10 5/8"
b'

Set Pointers for Height from Frame to Datum Line

1. Set pointers to correspond with datum line and points a and b
2. Set pointers to correspond with datum line and points b and c
3. Set pointers to correspond with dimension chart of car in the shop and check the frame accordingly

UNDER BODY MEASUREMENT
UNIT I

TEST

1. Match terms to definitions.

_____a. Imaginary line which is parallel to the floor of the automobile from which dimensions are plotted

_____b. Vertical line that cuts the car in half lengthwise

_____c. Condition occurs where the center of the car is sagging

_____d. Front or rear of the car has collapsed down

_____e. Condition occurs where the two frame rails are pointed in different directions instead of being parallel

_____f. Damage is straight causing buckles to appear on rail sides, on both the top and bottom of the rail, and on either side

_____g. Occurs where one rail is forward of the other; this damage can only be detected by use of tram gauges

_____h. Condition occurs where rail or rails are shifted to right or left

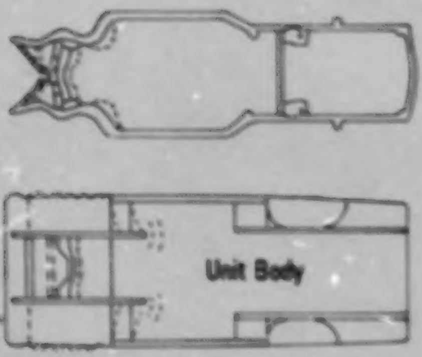
_____i. Consists of a horizontal bar, two vertical bars, and a sighting pin; regardless of what position it is in, the center sight remains in its center position

_____j. Consists of a long adjustable bar and two upright adjustable pointers for measuring over obstructions

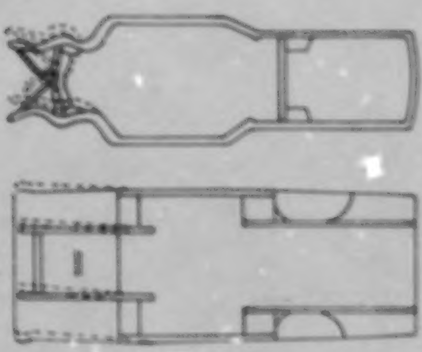
_____k. Determines whether the rear wheels follow the front wheels properly

1. Collapse
2. Mash
3. Self-centering gauge
4. Diamond
5. Datum line
6. Tram gauge
7. Center line
8. Twist
9. Tracking
10. Sag
11. Sidesway

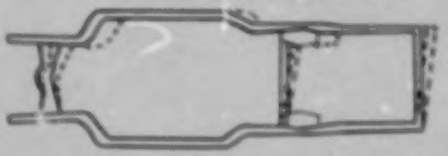
2. Identify from illustrations the five conditions found in frame damage.



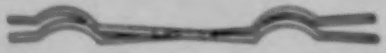
a. ______________________________



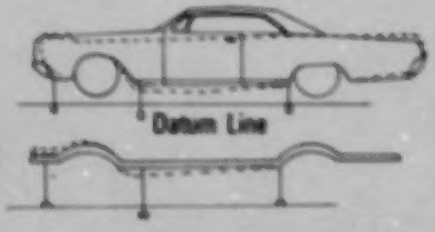
b. ______________________________



c. ______________________________



d. ______________________________



e. ______________________________

3. Name two methods for obtaining frame specifications for measurement.

   a.

   b.

4. Name the major points necessary for frame measurement.

   a.

   b.

   c.

   d.

      1)

      2)

      3)

      4)

      5)

      6)

      7)

5. Name the two measurements that can be performed at all major measuring points.

   a.

   b.

6. List the three measuring devices used in frame measurement.

   a.

   b.

   c.

7. List three ways centering gauges are used.

   a.

   b.

   c.

8. Describe how to locate the center line using centering gauges.

9. Describe how the centering gauges should be hung from frame rails.

10. List the three specifications that a body man must have to set up a tram gauge.

    a.

    b.

    c.

11. Describe how the tram gauge is set up.

12. List the sequence for repairing damaged frames.

    a.

    b.

    c.

    d.

    e.

13. Demonstrate the ability to:

    a. Use the self-centering gauge.

    b. Use the tram gauge.

    (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

UNDER BODY MEASUREMENT
UNIT I

ANSWERS TO TEST

1. a. 5
   b. 7
   c. 10
   d. 1
   e. 8
   f. 2
   g. 4
   h. 11
   i. 3
   j. 6
   k. 9
2. a. Mash
   b. Sway
   c. Diamond
   d. Twist
   e. Sag
3. a. Frame dimension charts or books
   b. Measuring and comparing damaged vehicle to an undamaged vehicle
4. a. Overall length
   b. Width
   c. Cross (diagonal) measurement
   d. Location of
      1) Front suspension
      2) Rear suspension

3) Steering gear

4) Idler arm

5) Transmission support

6) Bumper attachment

7) Body and fender mount holes

5. a. Distance from the next reference point

   b. Distance to the datum line

6. a. Tape measure

   b. Tram gauge

   c. Self-centering gauge

7. a. To locate the center of the car

   b. To detect any twist condition

   c. To see the datum line

8. To locate the center line, use centering gauges and hang them from the frame using identical points on each side of the frame; the centering pins will line up with each other thus locating the center line

9. Centering gauges should be hung from the frame rails using identical points on each side; some gauges have magnetic hangers eliminating the need to search for identical frame holes and braces

10. a. Height of pointer at position A

    b. Height of pointer at position B

    c. Distance between them as measured along the datum line

11. The tram gauge is set by measurement; the pointers are adjustable for height and are set at distances derived, using frame dimension charts, from a point on the frame to the datum line; the length of the tram bar is set according to the distance between two designated points on the frame along the datum line

12. a. Correct the length

    b. Correct the width

    c. Correct the height

    d. Correct the diamond condition

    e. Correct twist condition

13. Performance skills will be evaluated according to the criteria listed on the progress chart.

FRAME ALIGNMENT
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with frame alignment and determine the method of repair from the type of damage present. He should be able to align damaged frame members and straighten the damage to original specifications and dimensions. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with frame alignment to definitions.
2. Identify six different shapes of frame rail and cross member construction.
3. List two uses of portable or fixed frame straightening units.
4. Name five types of frame and body straightening units.
5. Identify three basic hookups used in frame and body repair.
6. Describe the advantage of the fixed frame straightening unit over the portable frame straightening unit.
7. List three methods for frame and body straightening repair.
8. Name two conditions that must be repaired to prevent weakening in damaged frame members.
9. List in order the repair and checking sequence that should be followed when straightening a damaged frame.
10. Describe how the anchor should be connected to a unitized frame.
11. State a rule for the heating of mild steel.
12. State a rule for the pulling limits of mild steel.
13. Demonstrate the ability to:
    a. Straighten and align mash frame damage.
    b. Straighten and align sag frame damage.
    c. Straighten and align twist frame damage
    d. Straighten and align sway frame damage.
    e. Straighten and align diamond frame damage.

FRAME ALIGNMENT
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Basic Frame Nomenclature

    2. TM 2--Pinch Weld

    3. TM 3--Frame Clamps and Pull Plate

    4. TM 4--Anchoring Methods

   5. TM 5--Anchoring Methods
   6. TM 6--Multiple Hookup and Fishplating
   7. TM 7--Shapes of Frame Rail and Cross Member Construction
   8. TM 8--Portable Frame Straightening Units
   9. TM 9--Stationary Frame Unit
   10. TM 10--Stationary Frame Floor Mount Unit
   11. TM 11--Vacuum Mount Frame and Body Unit
   12. TM 12--Types of Pulls

D. Job Sheets

   1. Job Sheet #1--Straighten and Align Mash Frame Damage
   2. Job Sheet #2--Straighten and Align Sag Frame Damage
   3. Job Sheet #3--Straighten and Align Twist Frame Damage
   4. Job Sheet #4--Straighten and Align Sway Frame Damage
   5. Job Sheet #5--Straighten and Align Diamond Frame Damage

E. Test

F. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Company of Canada Limited, 1969.

B. McPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Book Company, Inc., 1971.

C. *Repair Collision Damage with the Modern, Work Saving Koreck Body/Frame Repair System.* Milwaukee, Wisconsin 53227. Blackhawk Mfg. Company, Division of Applied Power Industries, Inc., 1968.

FRAME ALIGNMENT
UNIT II

INFORMATION SHEET

I. Terms and definitions (Transparencies 1, 2, 3, 4, 5, and 6)

A. Frame rail--The side rails of the frame system which are tied together with cross members and braces to form the frame of an automobile

B. Frame horn--That portion of the frame ahead of the front cross member where the bumper bolts to the frame

C. Cross member--Frame sections used to tie the two frame rails together to form the frame

D. Pinch weld--Two flanges welded together along their edges; type construction found where the rocker panel welds to the floor pan

E. Portable frame unit--Frame straightening unit which can be moved from vehicle to vehicle to straighten the frame and body

F. Stationary frame unit--Frame straightening system that is stationary and the vehicle must be placed on it for frame and body straightening purposes

G. Self-tightening clamp--Type of frame clamp where increased pressure makes the jaws of the clamp pull taut on the metal

H. Underbody clamp--Used to provide the anchor along pinchwelds; this type of clamp must be used with unit frame construction

I. Pull plate--A plate used to bolt to the frame providing a pull location where one is not available in the frame

J. Anchor--Tie down points to hold the automobile when using frame straightening units

K. Multiple hookup--Performing several pulls at the same time

L. Tracking--The rear wheels following the front wheels of an automobile properly

M. Dog tracking--When the rear wheels do not follow the front wheels properly

N. Combination damage--Several types of frame damage occuring at the same time

Examples: Mash, twist, diamond, or others

O. Fishplating--Strengthening a frame by welding, riveting, or bolting a plate or rail to it

INFORMATION SHEET

II. Shapes of frame rail and cross member construction (Transparency 7)

- A. Channel
- B. Open box
- C. Closed box
- D. Double boxed channel
- E. Beam
- F. Tubular

III. Uses of frame straightening units

- A. Used to straighten frames
- B. Used to straighten sheet metal

IV. Types of frame and body straightening units (Transparencies 8, 9, 10, and 11)

- A. Rail with fixed vertical support
- B. Rail with swinging vertical support
- C. Stationary frame rack
- D. Stationary floor mount
- E. Vacuum mount

V. Basic hookups used in frame straightening (Transparency 12)

- A. Pull and anchor
- B. Pull, block, and anchor
- C. Pull, hold down, and anchor

VI. Advantage of the fixed frame straightening unit over the portable frame straightening unit--Control over the vehicle anchor points and unlimited pulls can be made

VII. Methods for frame and body straightening repair

- A. Straighten the body separately from the frame
- B. Straighten the frame separately from the body
- C. Straighten body and frame at the same time

INFORMATION SHEET

VIII. Conditions in damaged frame members to be repaired

- A. Wrinkles and buckles on the metal surface
- B. Tears and breaks

IX. Order of repair and checking sequence for straightening a damaged frame

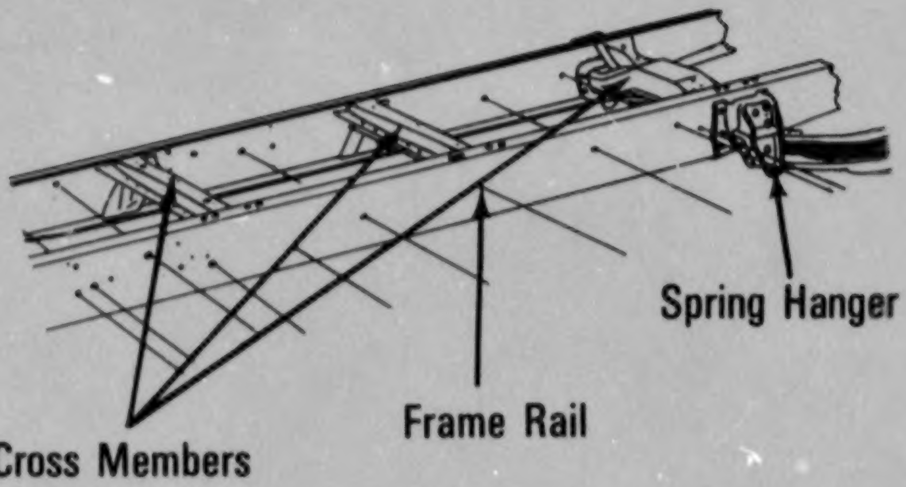
- A. Weld all cracks, tears, and split seams
- B. Correct length (mash)
- C. Correct height (sag)
- D. Correct width
- E. Correct sideway
- F. Correct twist
- G. Correct diamond
- H. Correct tracking

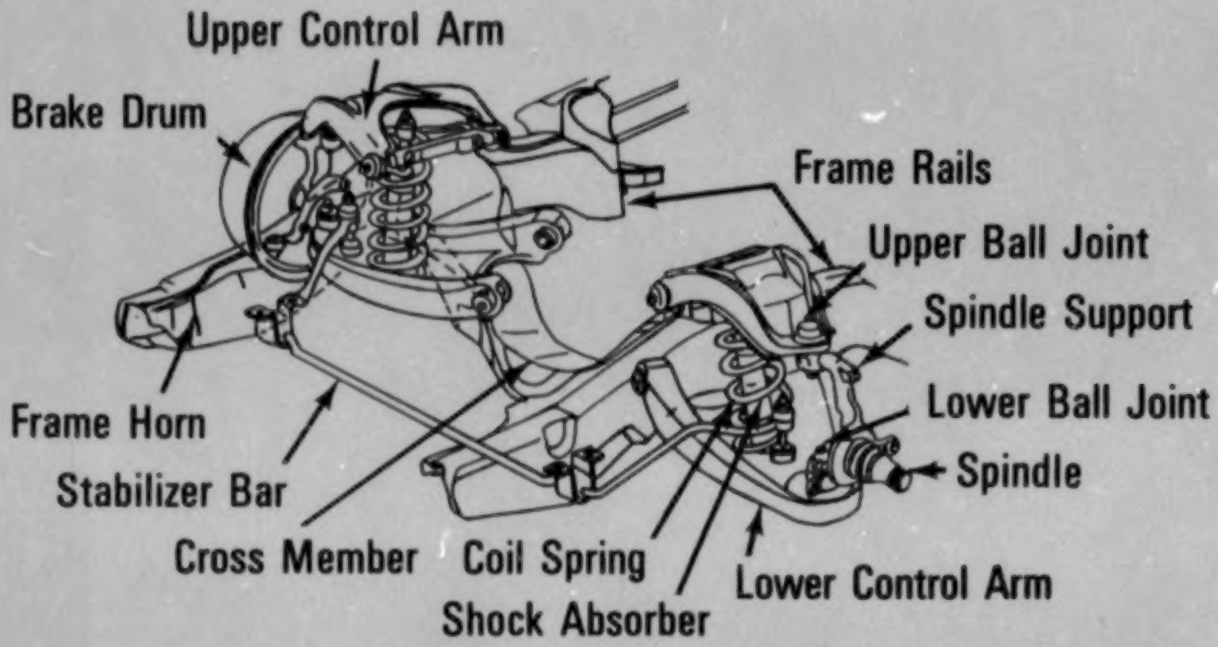
X. Connection of anchor to a unitized frame--The anchor points on a unitized body are underbody clamps that are fastened to the pinch weld along the underside of the floor pan; be sure to fasten the clamp in direct line with the direction of pull to prevent tearing the metal

XI. Rule for heating mild steel--Do not heat mild body or frame steel beyond cherry red hot

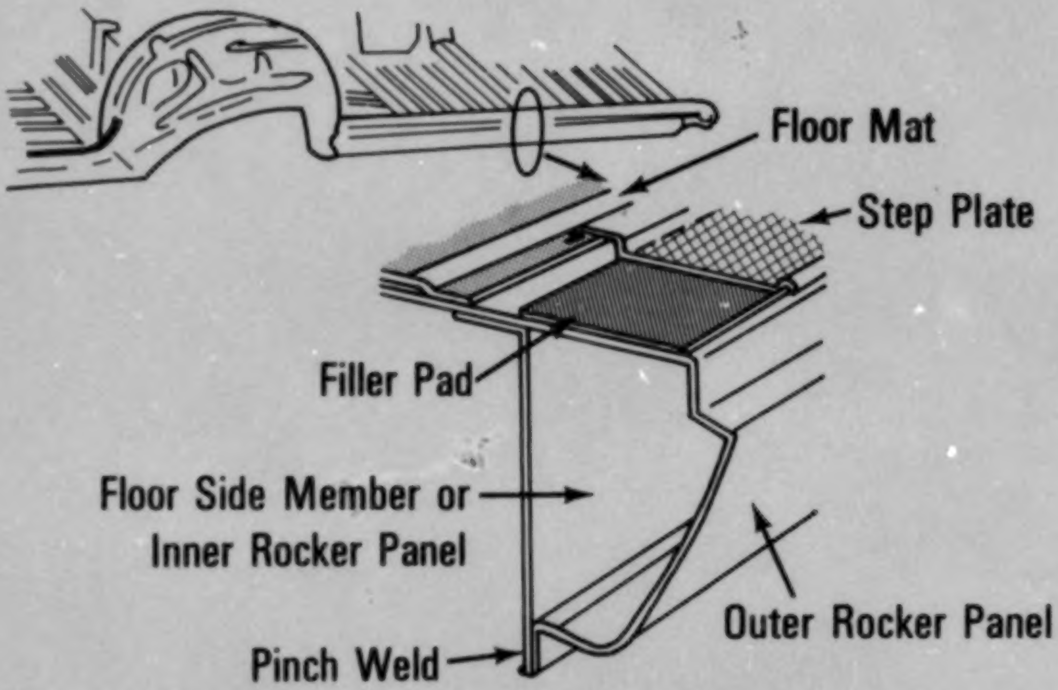
XII. Rule for pulling limits of mild steel--Do not continue to pull mild steel after movement of metal parts or members has stopped

Basic Frame Nomenclature


Spring Hanger
Frame Rail
Cross Members

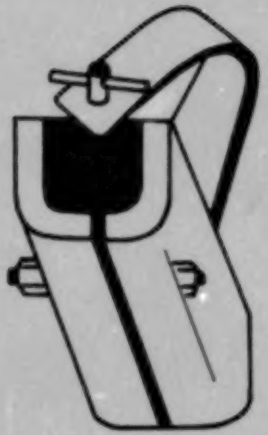

Upper Control Arm
Brake Drum
Frame Rails
Upper Ball Joint
Spindle Support
Lower Ball Joint
Spindle
Frame Horn
Stabilizer Bar
Cross Member
Coil Spring
Shock Absorber
Lower Control Arm

Pinch Weld

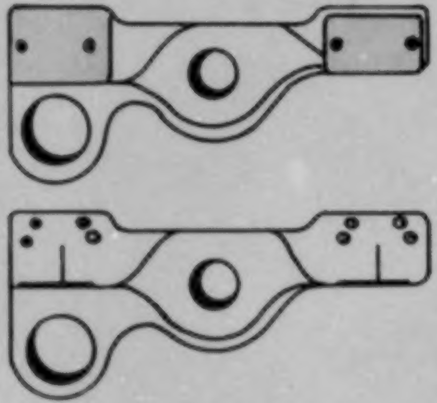

Floor Mat
Step Plate
Filler Pad
Floor Side Member or Inner Rocker Panel
Outer Rocker Panel
Pinch Weld

Cross-Section of Rocker Panel Construction

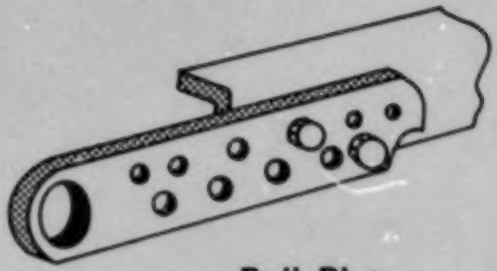
Frame Clamps and Pull Plate



Self-Tightening Pull Clamp

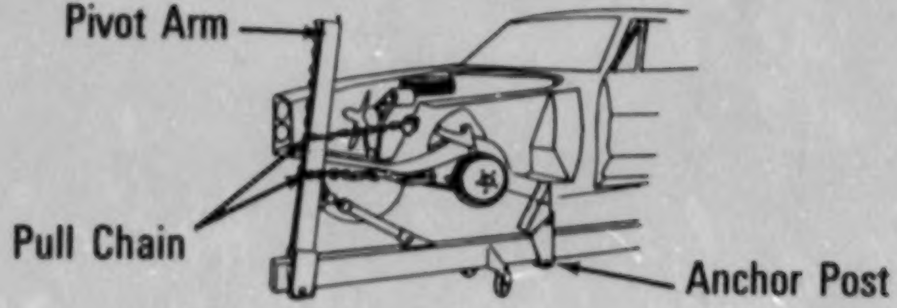


Underbody Clamps

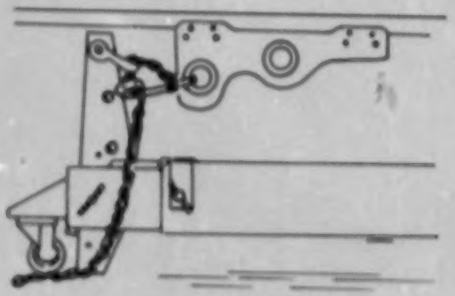


Pull Plate

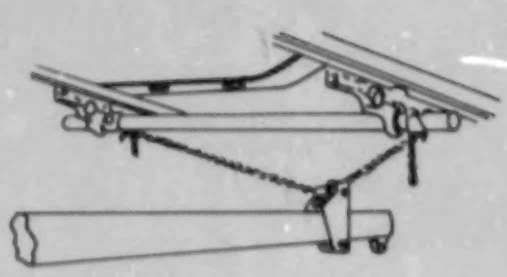
Anchoring Methods


Pivot Arm
Pull Chain
Anchor Post

ANCHOR POST



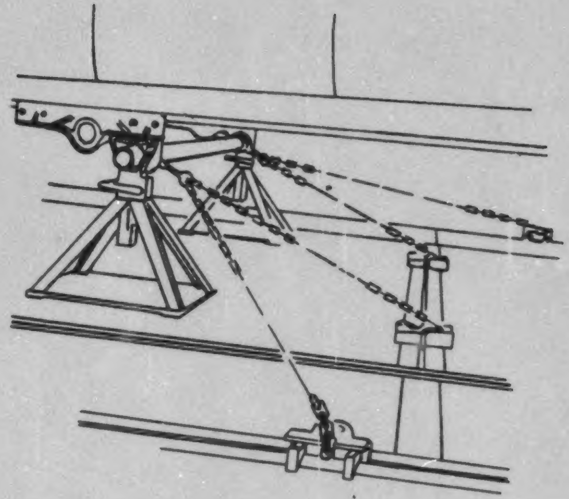
Pinch Weld Underbody Clamps

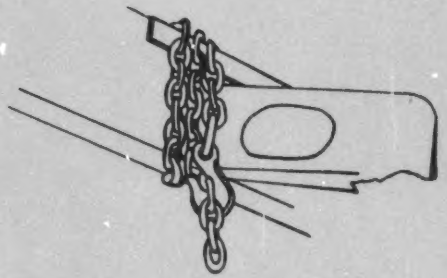


PINCH WELD CLAMPS and BAR

Anchoring Methods

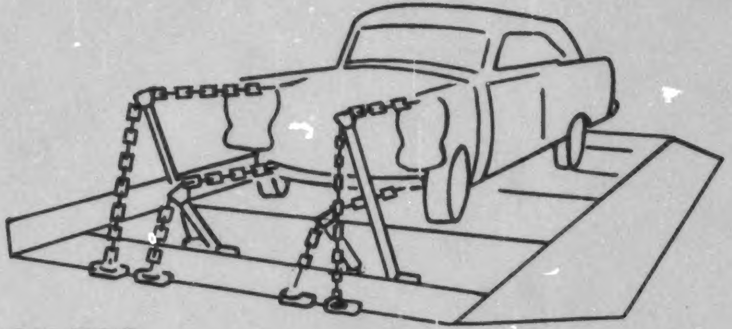
FLOOR TIE DOWNS



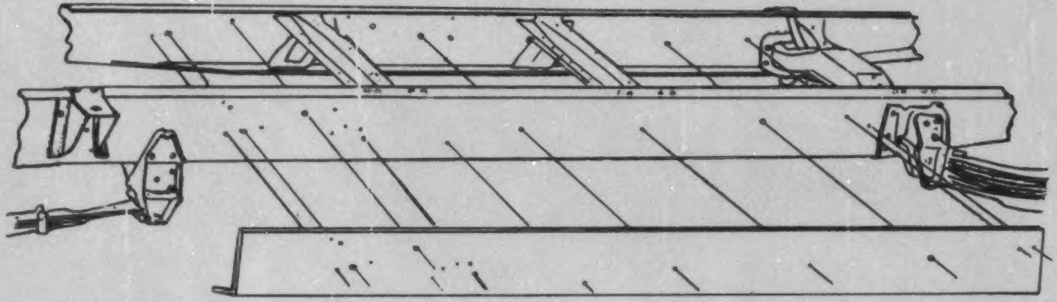


ANCHORING BY CHAINING
AROUND FRAME or CROSS MEMBER

Multiple Hookup and Fishplating

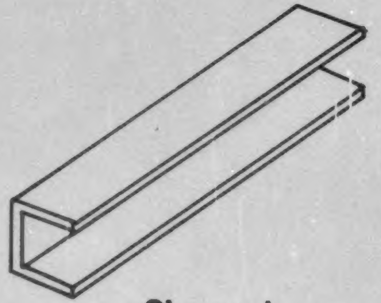


MULTIPLE HOOK-UPS

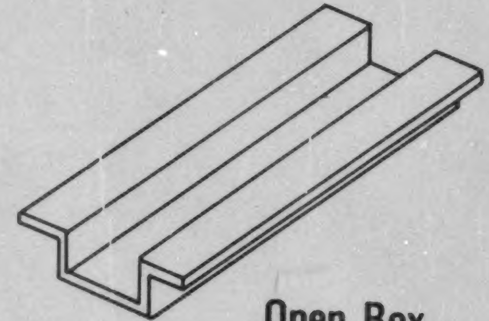


FISHPLATING

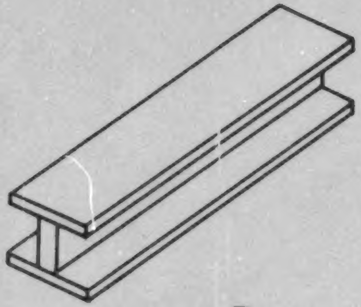
Shapes of Frame Rail and Cross Member Construction



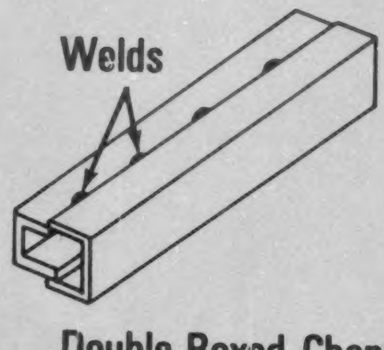
Channel



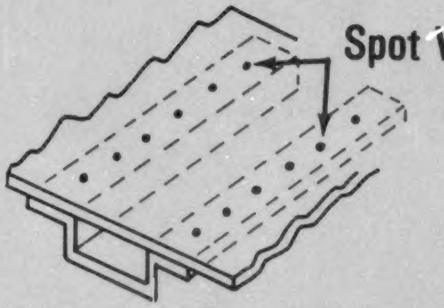
Open Box



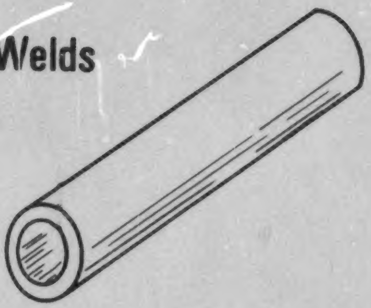
Beam



Double-Boxed Channel

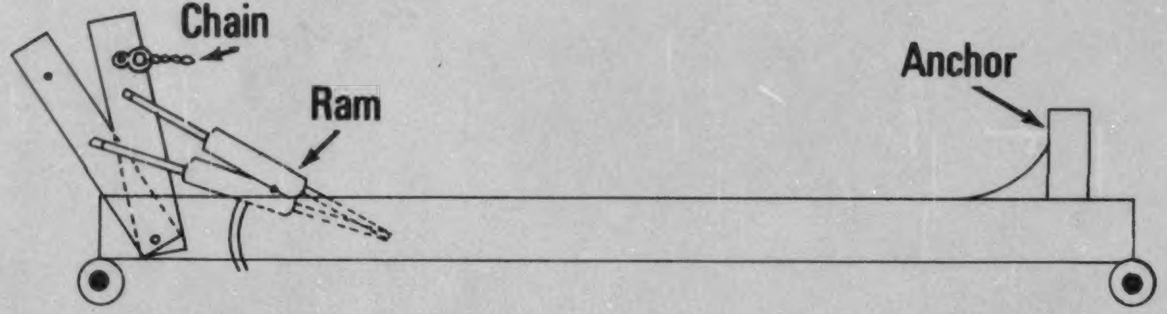


Closed Box

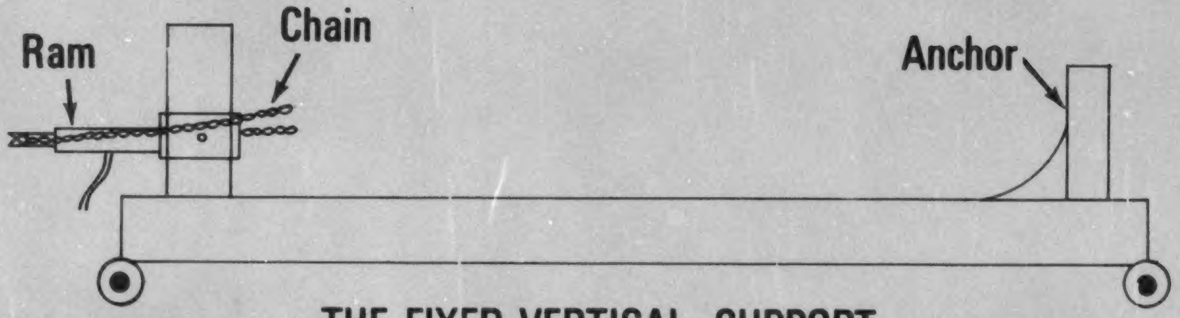


Tubular

Portable Frame Straightening Units

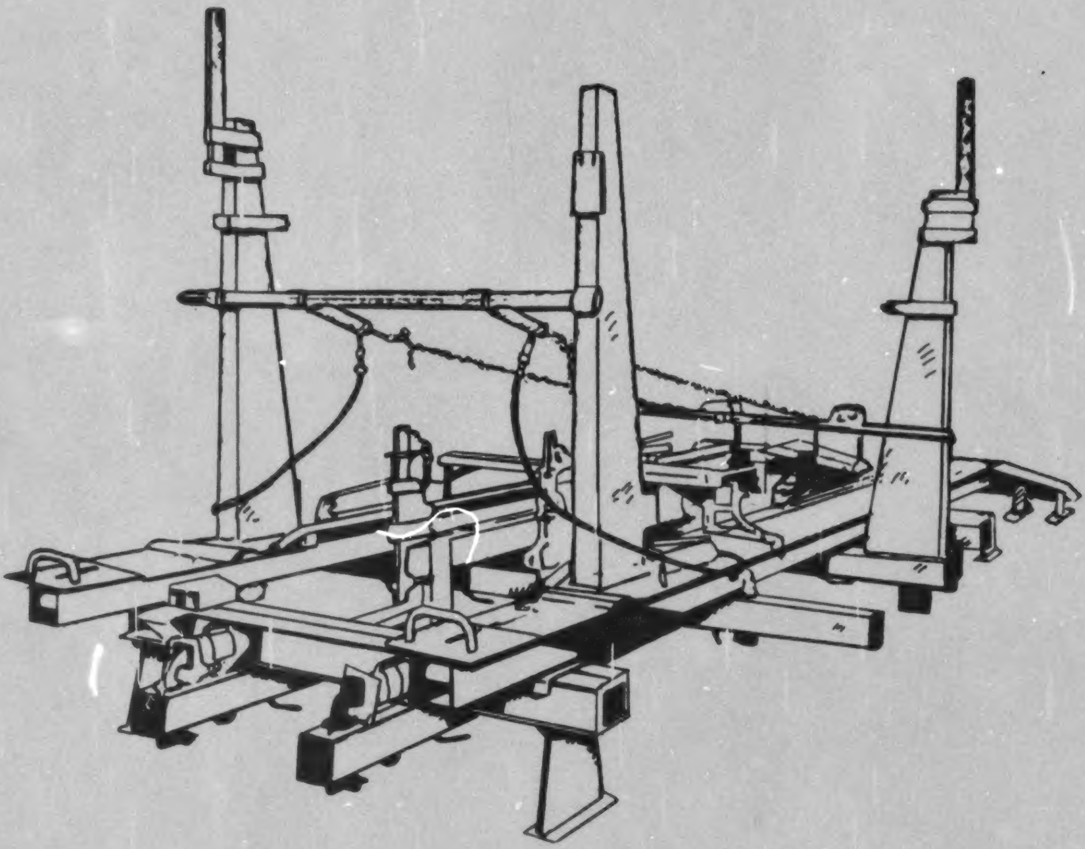

Chain
Ram
Anchor

THE SWINGING VERTICAL SUPPORT

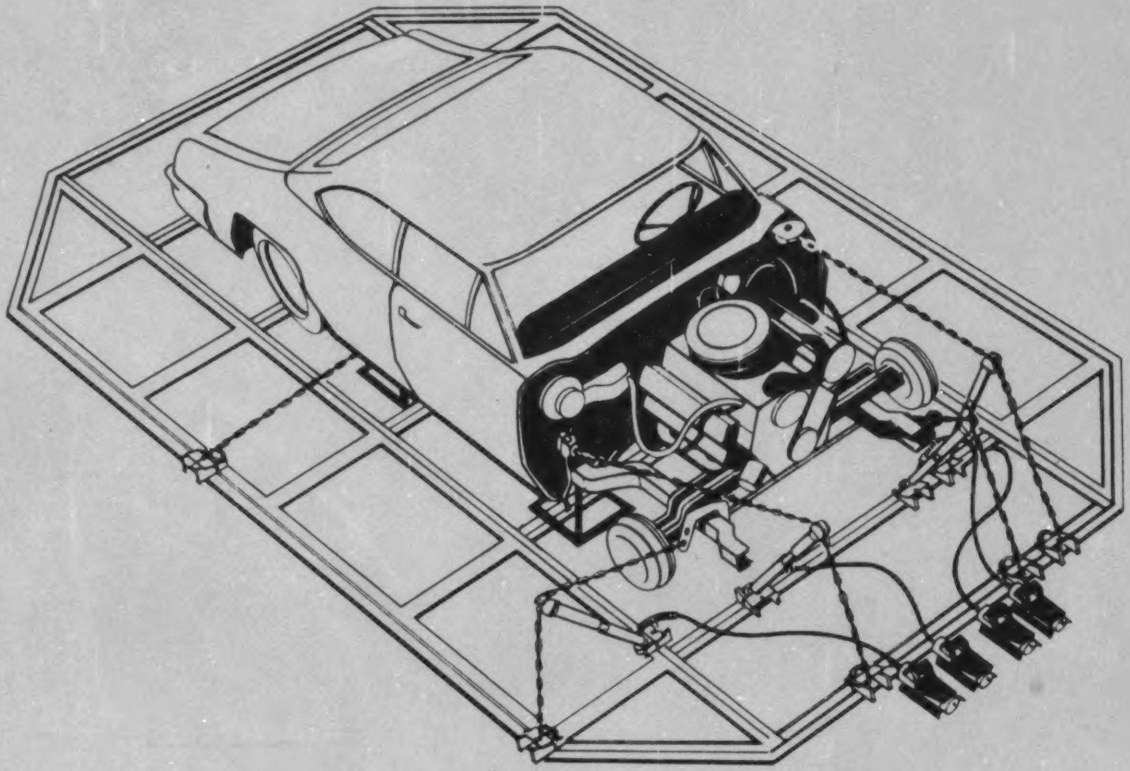

Ram
Chain
Anchor

THE FIXED VERTICAL SUPPORT

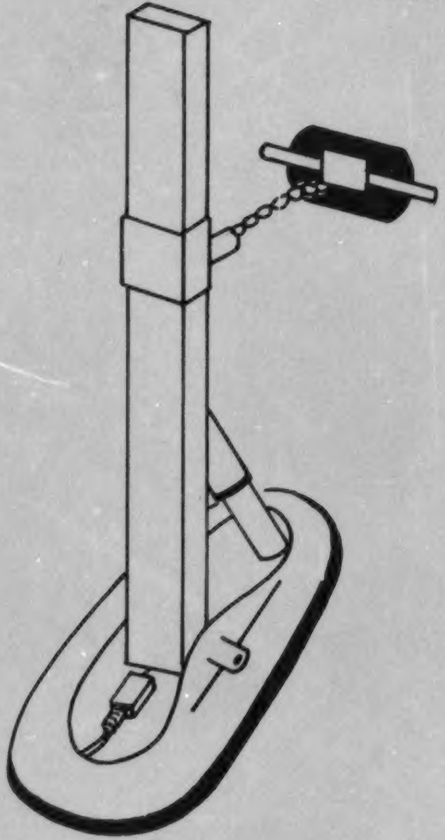
Stationary Frame Unit

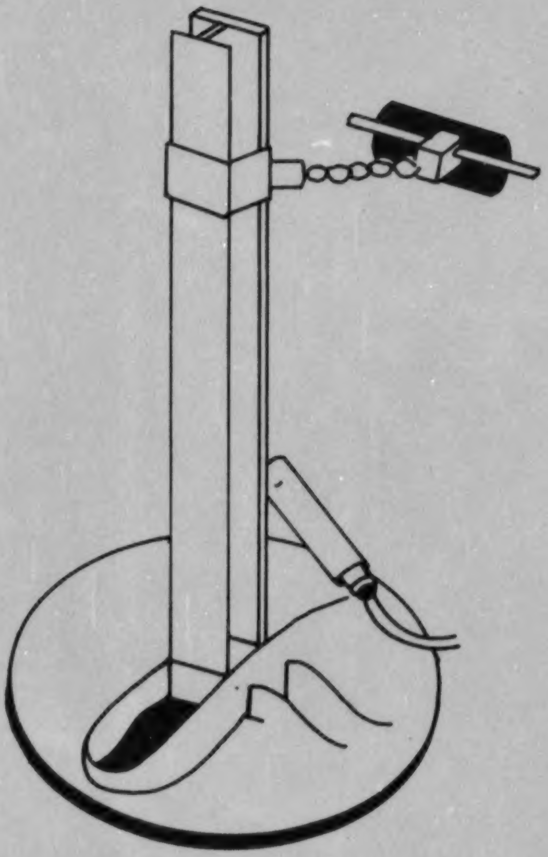


Stationary Floor Mount Unit



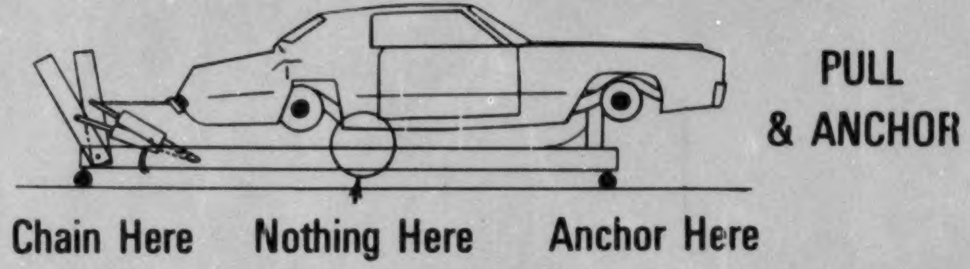
Vacuum Mount Frame and Body Unit



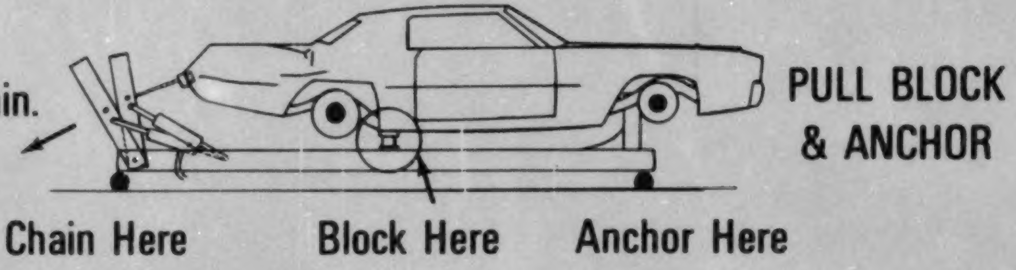


Types of Pulls

The corrective forces will always follow the direction of the chain as it first leaves the car.

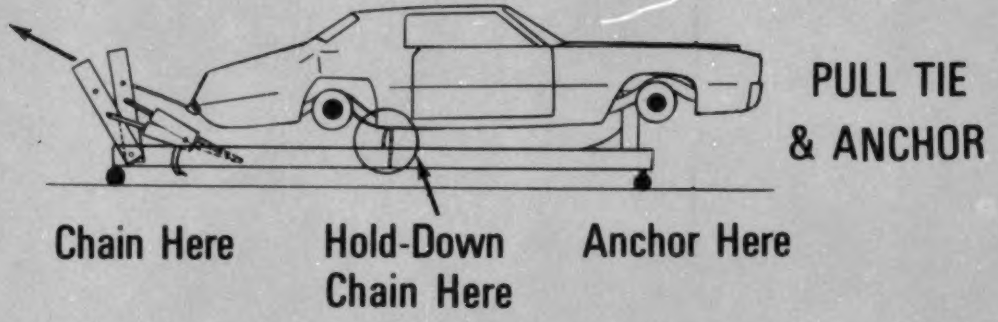

PULL
& ANCHOR
Chain Here
Nothing Here
Anchor Here

Corrective forces are again in line with the direction of the chain.


PULL BLOCK
& ANCHOR
Chain Here
Block Here
Anchor Here

When the chain is pointed up, a hold-down chain is required to prevent entire car from raising.

Corrective force is with chain.


PULL TIE
& ANCHOR
Chain Here
Hold-Down
Chain Here
Anchor Here

FRAME ALIGNMENT
UNIT II

JOB SHEET #1–STRAIGHTEN AND ALIGN MASH FRAME DAMAGE

I. Tools and equipment

   A. Bumping hammer

   B. Dolly blocks

   C. Finishing hammer

   D. Hydraulic jack set--10 ton

   E. Hydraulic jack

   F. Frame machine (portable or stationary)

   G. Oxyacetylene torch

   H. AC or DC welding unit

   I. Welding rod

   J. Measuring tape

   K. Self-centering gauges

   L. Tram gauge

   M. Frame dimension charts

II. Procedure

   A. Analyze the damage

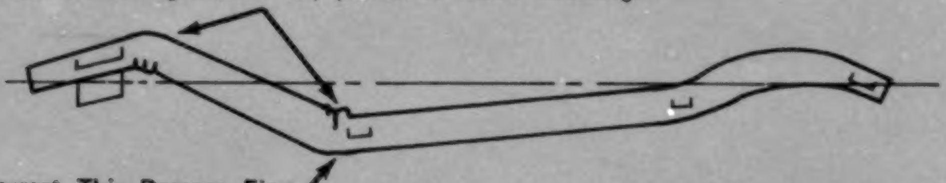
      1. Determine extent of damage

JOB SHEET #1

2. Determine what parts must be removed to gain access to pull points (Figures 1 and 2)

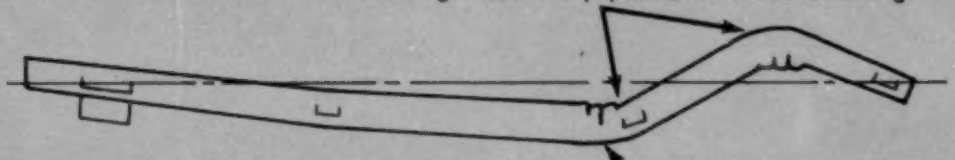
FIGURE 1

Frame mashed and buckled from front end collision showing most likely points of frame buckling.



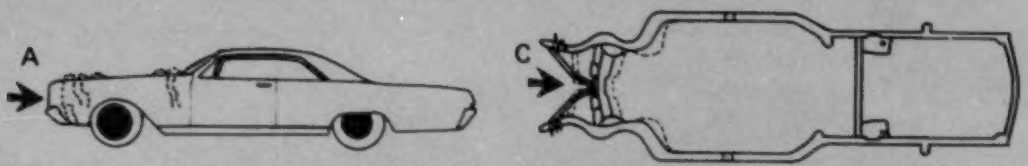
Correct This Damage First

Frame mashed and buckled from rear end collision showing most likely points of frame buckling.



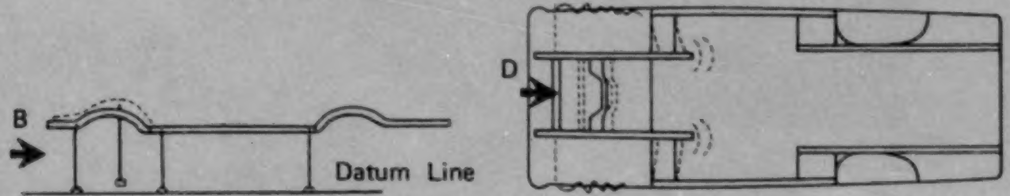
Correct This Damage First

FIGURE 2



Front of car is shortened (mashed) by head-on collision.

Mash damage in a perimeter frame causes the front torque boxes to roll rearward.



Frame gage hung at wheel arch will appear high.

Mashed in a unitized construction vehicle generally will cause wrinkles in the floor pan area.

(NOTE: It is always better to perform pulls with body parts intact to help with alignment of the body section of the automobile.)

JOB SHEET #1

B. Set up frame equipment to correct damage

1. Place automobile on safety stands to get desired height
2. Gauge frame to determine damage from datum line (See Figure 2B.)
3. Place frame machine under damaged frame member

   (NOTE: If two portable frame units are available, use both so pull can be made on both frame rails at the same time.)

   (NOTE: If a stationary type system is used, use two pull set ups so both frame rails can be pulled at the same time.)

4. Anchor frame to rear of frame machine
   a. Use double chain hookup
   b. Tie to strongest point possible in direct line from pulling point

      (NOTE: Do not tie chain to differential housing or light frame braces.) (Figures 3 and 4)

FIGURE 3

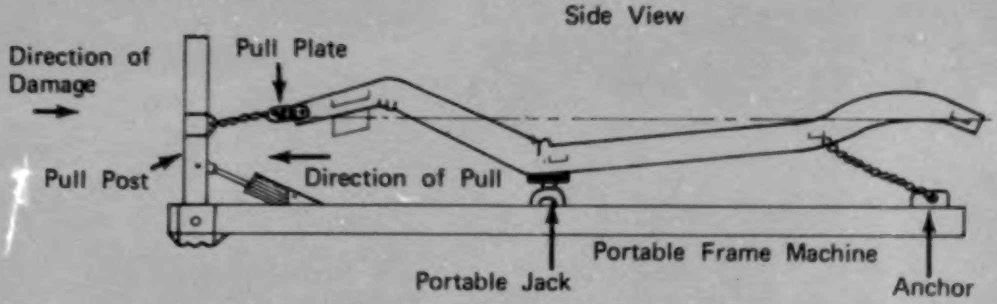
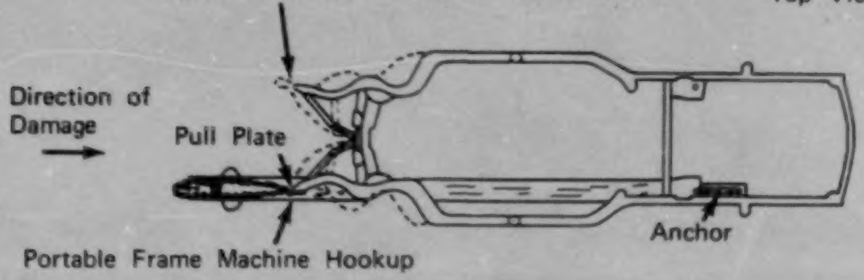

Side View
Direction of Damage
Pull Plate
Pull Post
Direction of Pull
Portable Frame Machine
Portable Jack
Anchor

FIGURE 4

If available, use two frame machines and pull both frame rails at the same time.


Top View of Mash
Direction of Damage
Pull Plate
Anchor
Portable Frame Machine Hookup

JOB SHEET #1

C. Pull frame rails

(NOTE: If only one frame machine is available, pull one side then the other, working from side to side until the frame is in proper alignment. Do not try to pull all damage out of each rail with one pull.)

(CAUTION: Check all chains for weak links, check anchor and pull points for strength, and do not stand in the plane of the pulling force. Always stand to the side and away from the vehicle when operating frame pulling units.) (Figure 5)

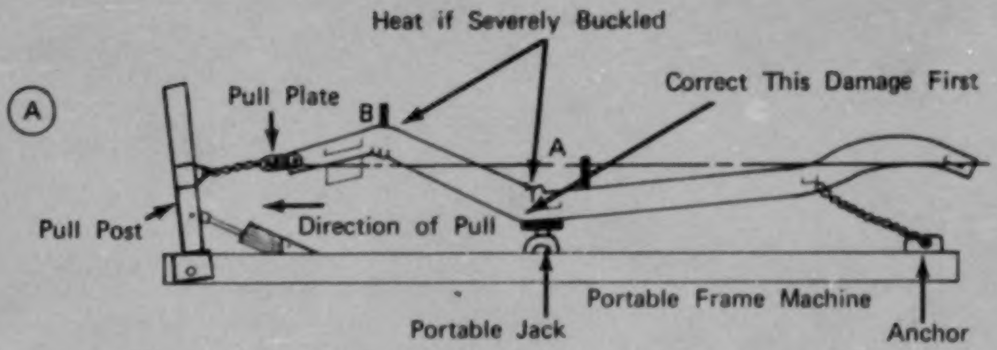
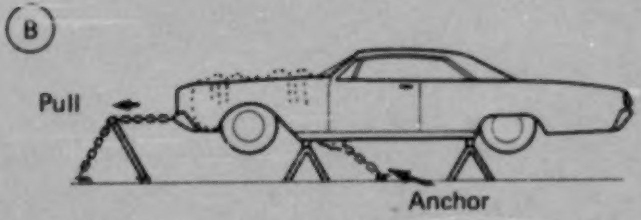

Heat if Severely Buckled
A
Pull Plate
B
A
Correct This Damage First
Pull Post
Direction of Pull
Portable Jack
Portable Frame Machine
Anchor

FIGURE 5


B
Pull
Anchor

Correcting Mash with Stationary Unit

JOB SHEET #1

1. Pull forward and down
2. Heat position "A" to relieve tension in metal

   (NOTE: Do not heat mild steel over cherry red hot or damage to the metal could result and weaken the frame rail.)
3. Continue to pull until "A" has returned to normal position
4. Heat position "B" and continue pulling pressure until it returns to correct position

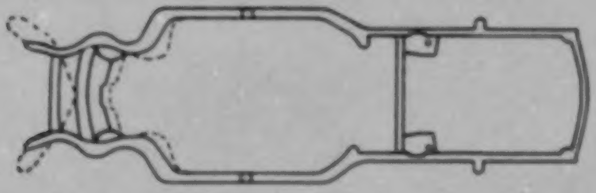
   (NOTE: Do not relieve pulling pressure unless the metal has cooled. Measure to prevent stretch from occuring.)

D. Work both side rails

1. Pull the left side rail until limit is reached
2. Pull the right side rail until limit is reached

(IMPORTANT: If only one frame machine is available, work from side to side until frame is straight.) (Figure 6)

FIGURE 6



Frame Pulled Back to Original Shape

3. Gauge frame with self-centering gauges
4. Gauge frame with a tram gauge
5. Check with frame dimension charts

JOB SHEET #1

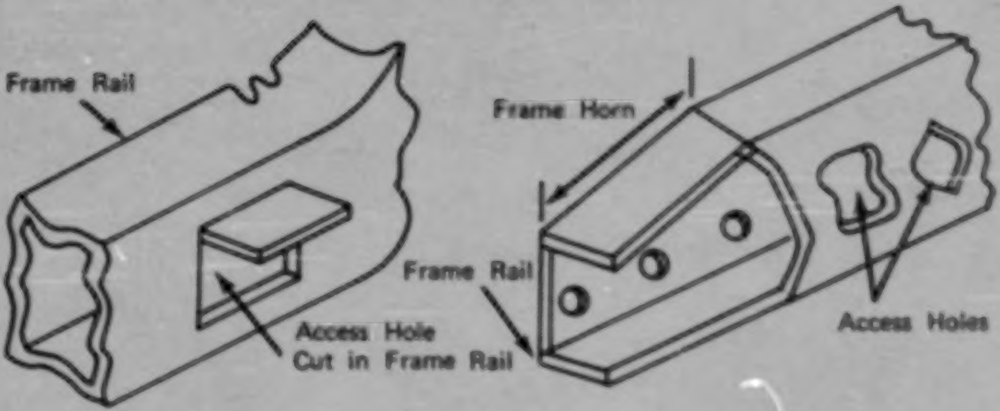
E. Finish straightening damaged frame

1. Straighten rails through access holes with hammer and dolly

   (NOTE: If an access hole is not available, cut one. Weld up when finish work is complete.)

2. Straighten frame horns with hammer and dolly (Figure 7)

FIGURE 7


Frame Rail
Access Hole
Cut in Frame Rail
Frame Horn
Frame Rail
Access Holes

   (NOTE: Use what ever type bar is necessary as a dolly block in inaccessable areas.)

3. Undercoat repair area

FRAME ALIGNMENT
UNIT II

JOB SHEET #2--STRAIGHTEN AND ALIGN SAG FRAME DAMAGE

I. Tools and equipment

   A. Bumping hammer

   B. Dolly blocks

   C. Finishing hammer

   D. Hydraulic jack set--10 ton

   E. Hydraulic jack

   F. Frame machine (portable or stationary)

   G. Oxyacetylene torch

   H. AC or DC welding unit

   I. Welding rod

   J. Measuring tape

   K. Self-centering gauges

   L. Tram gauge

   M. Frame dimension charts

II. Procedure

   A. Analyze the damage

      1. Determine extent of damage

JOB SHEET #2

2. Determine what parts must be removed to gain access to pull points

   (NOTE: It is always better to perform pulls with body parts intact to help correct alignment of the body section of the automobile.) (Figure 1)

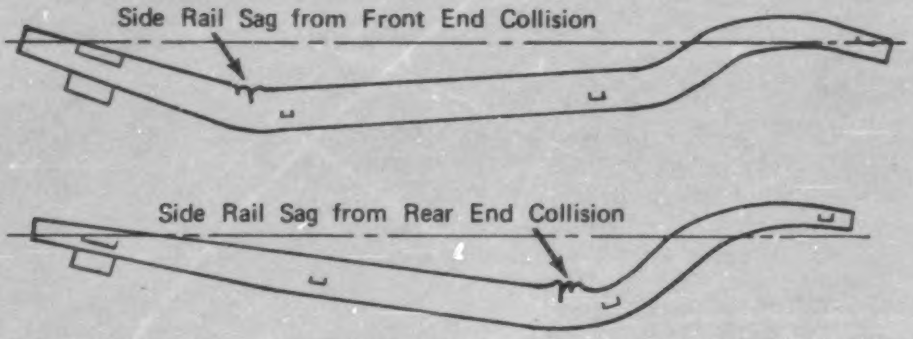
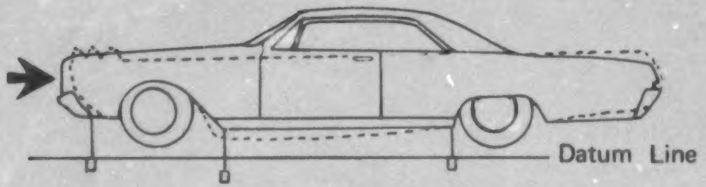
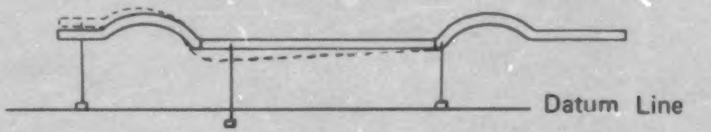

Side Rail Sag from Front End Collision
Side Rail Sag from Rear End Collision

FIGURE 1



Impact from the front or rear end of the car causes the car to droop near the center.



Damage is detected by using three or more gages at key points on the frame. Note center gage is low.

B. Set up frame equipment to correct damage

   1. Place automobile on safety stands to get desired height

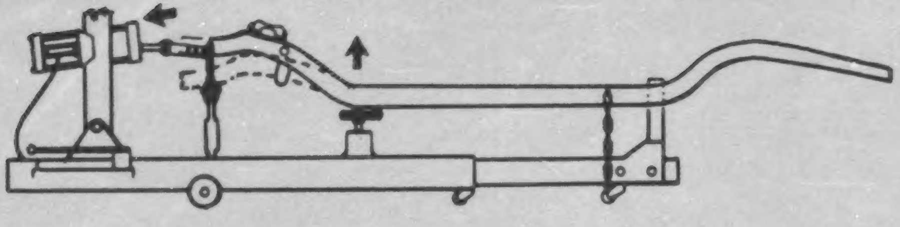
   2. Gauge frame to determine damage from datum line

   3. Place frame machine under damaged frame member

      (NOTE: If possible use two hookups to push both frame rails at the same time.)

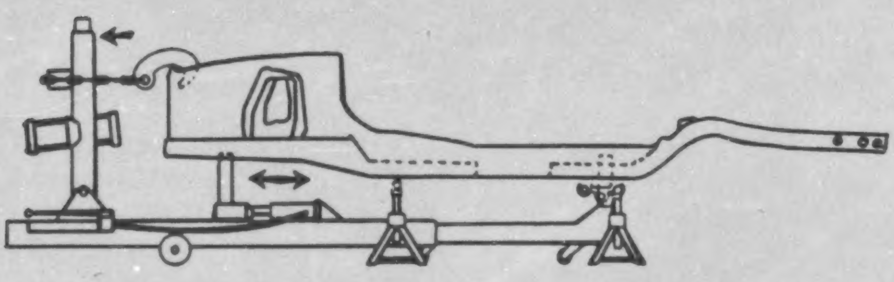
JOB SHEET #2

4. Anchor rail to frame at the front and the rear of sag area
    a. Use double chain hookup
    b. Tie completely around the frame (Figure 2)



Portable Jack

FIGURE 2



Unitized Body

(NOTE: Do not tie to light metal supports.)

C. Push frame rails

(NOTE: If only one frame machine is available, push one side of the frame then the other working from side to side until the frame is in proper alignment. Do not try to push all damage out with one push.)

JOB SHEET #2

(CAUTION: Check all chains for weak links, check anchor and pull points for strength, and do not stand in the plane of the pulling force. Always stand to the side and away from the vehicle when operating frame pulling units.) (Figure 3)

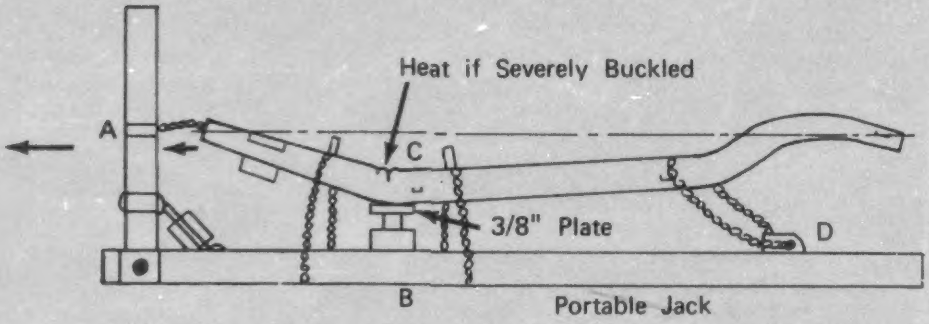
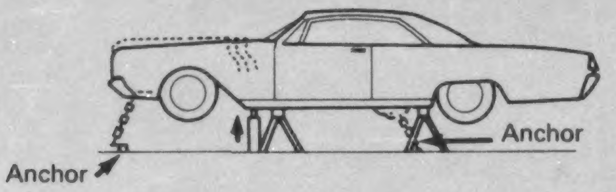


FIGURE 3



Set-Up for Repairing Sag with Stationary Unit

1. Apply tension on points "A" and "D" with frame machine

   (NOTE: Do not try to pull damage with this method. Apply tension only.)

2. Push up on frame at point "C" with portable jack

3. Heat area "C" and push at "B" until frame is straight

   (NOTE: Do not relieve pressure until metal has cooled.)

D. Work both side rails

   1. Push left side rail until limit is reached

   2. Push right side rail until limit is reached

      (IMPORTANT: If only one portable frame machine is available, work from side to side until frame is straight.)

   3. Gauge frame with self-centering gauges

      (NOTE: Horizontal bars will indicate when frame is straight.)

JOB SHEET #2

E. Finish straightening damaged frame

1. Straighten frame through access holes in side rail
2. Cut access hole if necessary and straighten rail (Figure 4)
3. Weld the cut access hole shut
4. Undercoat repaired area

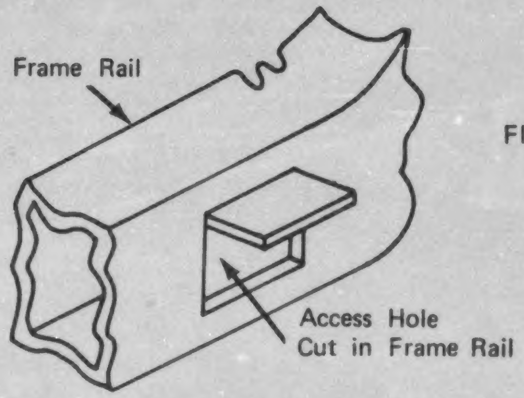

Frame Rail
Access Hole
Cut in Frame Rail

FIGURE 4

FRAME ALIGNMENT
UNIT II

JOB SHEET #3--STRAIGHTEN AND ALIGN TWIST FRAME DAMAGE

I. Tools and equipment

  A. Bumping hammer

  B. Dolly blocks

  C. Finishing hammer

  D. Hydraulic jack set--10 ton

  E. Hydraulic jack (hand)

  F. Frame machine (portable or stationary)

  G. Oxyacetylene torch

  H. AC or DC welding unit

  I. Welding rod

  J. Measuring tape

  K. Self-centering gauges

  L. Tram gauge

  M. Frame dimension charts

JOB SHEET #3

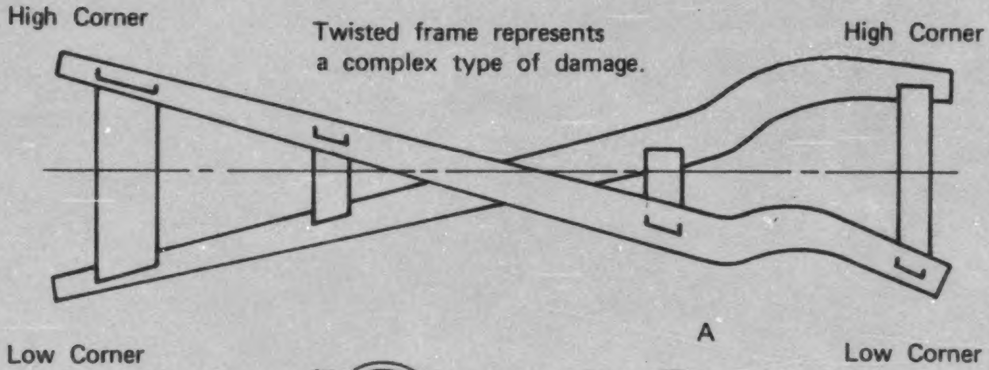
II. Procedure

A. Analyze the damage

1. Determine extent of damage

2. Determine what parts must be removed to gain access to pull points (Figure 1)

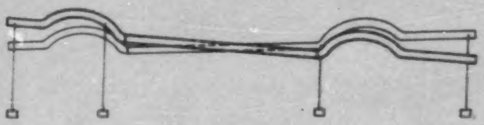
(NOTE: It is always better to perform pulls with body parts intact to help correct alignment to the body section of the automobile.)



Twisted frame represents a complex type of damage.

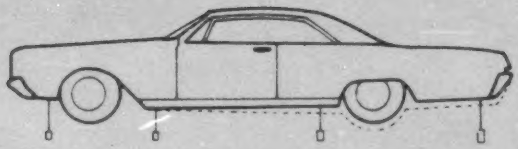
FIGURE 1

A



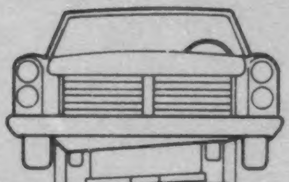
When viewed from the side, a twisted frame makes a shallow "X."

B



Gages should be hung to detect the high corners.

C



Tilting horizontal bars indicate twist.

JOB SHEET #3

B. Set up frame equipment to correct damage

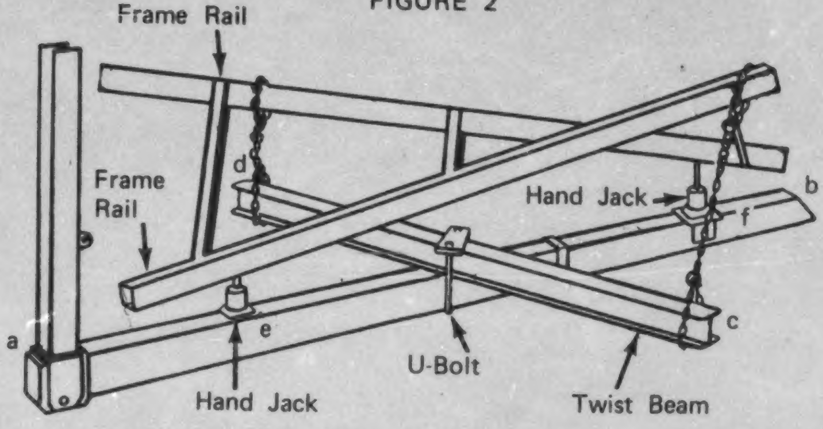
1. Place automobile on safety stands to get desired height

2. Gauge frame to determine damage from datum line (See Figure 1c.)

3. Place frame machine under damaged frame members as illustrated

    a. Portable unit (Figure 2)

FIGURE 2


Frame Rail
d
Frame
Rail
Hand Jack
b
f
a
e
c
Hand Jack
U-Bolt
Twist Beam

1) Twist beam C-D across high points

2) Chain both ends of frame to ends of twist beams

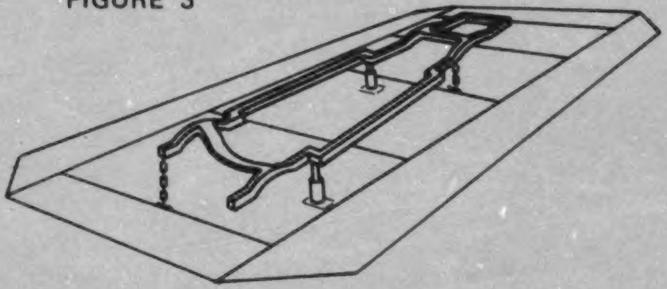
3) Place main beam, A-B, across low points

4) Place hand jacks against frame resting on main beam at points "E" and "F"

JOB SHEET #3

b. Stationary unit (Figure 3)

FIGURE 3



1) Tie down the high points to frame straightening unit with chains

2) Place hand jack or vertical rams under low points

C. Push frame rails at low points until frame is straight

(NOTE: Push both rails at the same time if possible.)

(CAUTION: Check all chains for weak links, check anchor and pull points for strength, and do not stand in the plane of the pulling force. Always stand to the side and away from the vehicle when operating frame pulling units.)

D. Gauge frame with self-centering gauges

(NOTE: Horizontal bars must be parallel to datum line and to each other when frame is straight.)

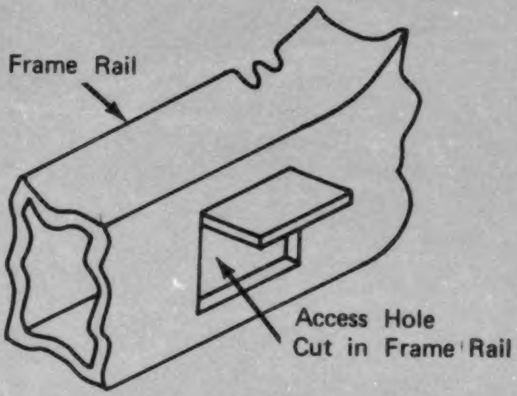
JOB SHEET #3

E. Finish straightening damaged frame rails

1. Straighten frame through access holes in side rails

2. Cut access hole if necessary and straighten rail (Figure 4)

FIGURE 4


Frame Rail
Access Hole
Cut in Frame Rail

3. Weld the cut access hole shut

   (NOTE: Frame rail damage is not common to this type of frame damage.)

4. Undercoat repaired areas

FRAME ALIGNMENT
UNIT II

JOB SHEET #4--STRAIGHTEN AND ALIGN SWAY FRAME DAMAGE

I. Tools and equipment

- A. Bumping hammer
- B. Dolly blocks
- C. Finishing hammer
- D. Hydraulic jack set--10 ton
- E. Hydraulic jack (hand)
- F. Frame machine (portable or stationary)
- G. Oxyacetylene torch
- H. AC or DC welding unit
- I. Welding rod
- J. Measuring tape
- K. Self-centering gauges
- L. Tram gauge
- M. Frame dimension charts

JOB SHEET #4

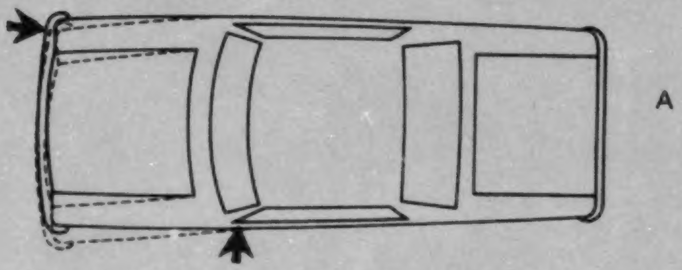
II. Procedure

A. Analyze the damage

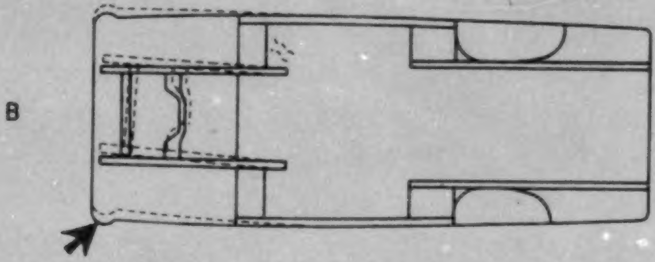
1. Determine extent of damage

2. Determine what parts must be removed to gain access to pull points (Figure 1)

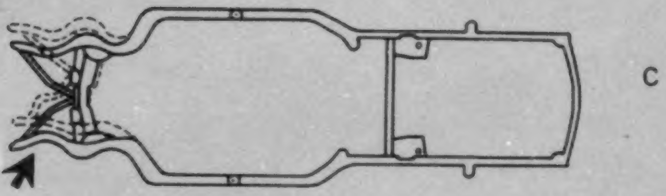
FIGURE 1



Sway is caused by sideways impact on the vehicle.



Bottom view of unitized body swayed in front. The damage usually will extend back into floor pan area.



Bottom view or frame swayed in front.

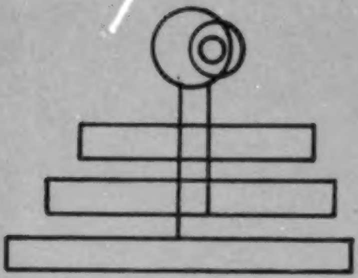
(NOTE: It is always better to perform pulls with body parts intact to help correct alignment to the body section of the automobile.)

JOB SHEET #4

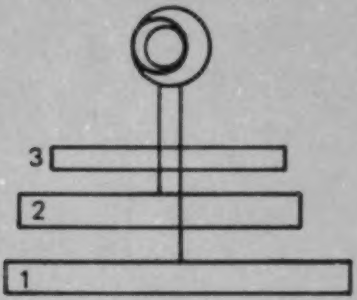
B. Set up frame equipment to correct damage

1. Place automobile on safty stands to get desired height
2. Gauge frame to determine damage (Figure 2)

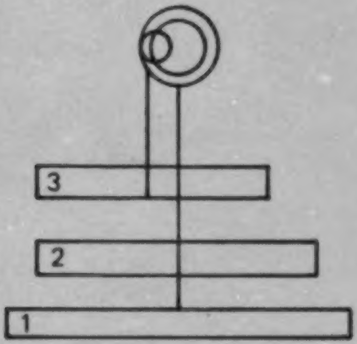
FIGURE 2



Gauge Shows Front Sway



Gauge Shows Center Sway



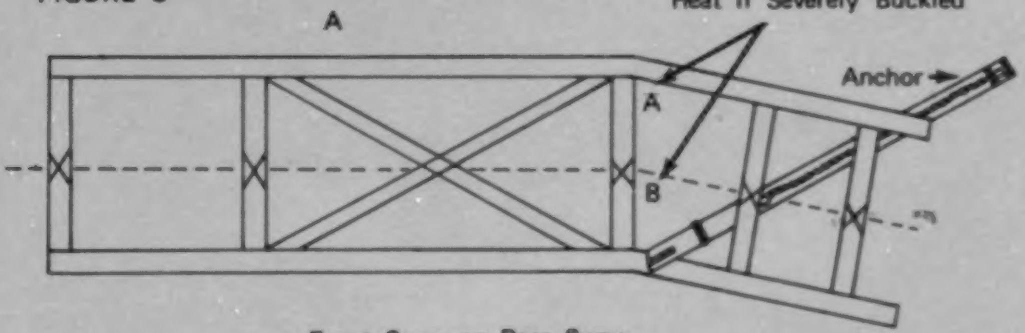
Gauge Shows Rear Sway

JOB SHEET #4

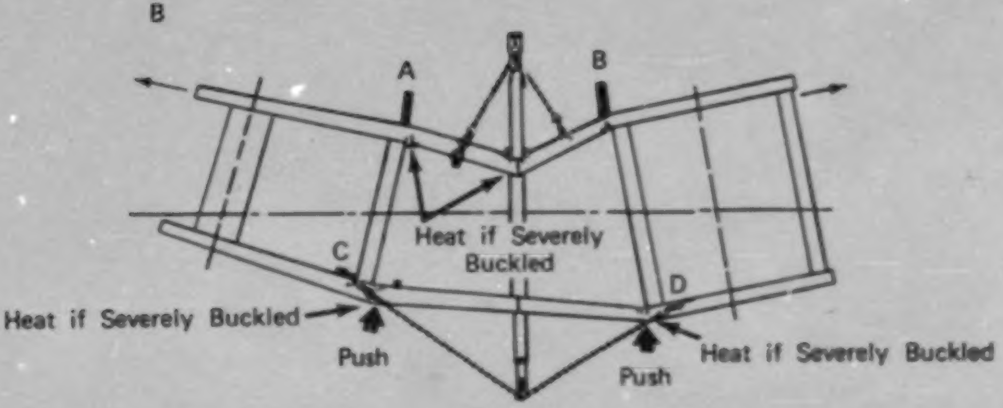
5. Place machine under damaged frame members

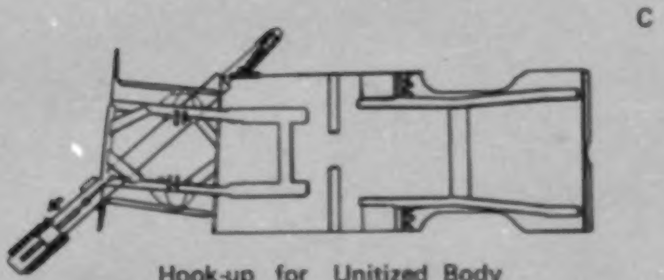
   a. Portable unit (Figure 3)

FIGURE 3


A
Heat if Severely Buckled
Anchor
A
B

Front Sway or Rear Sway


B
A
B
Heat if Severely Buckled
C
D
Heat if Severely Buckled
Push
Push
Heat if Severely Buckled



Hook-up for Unitized Body

JOB SHEET #4

b. Stationary unit (Figure 4)

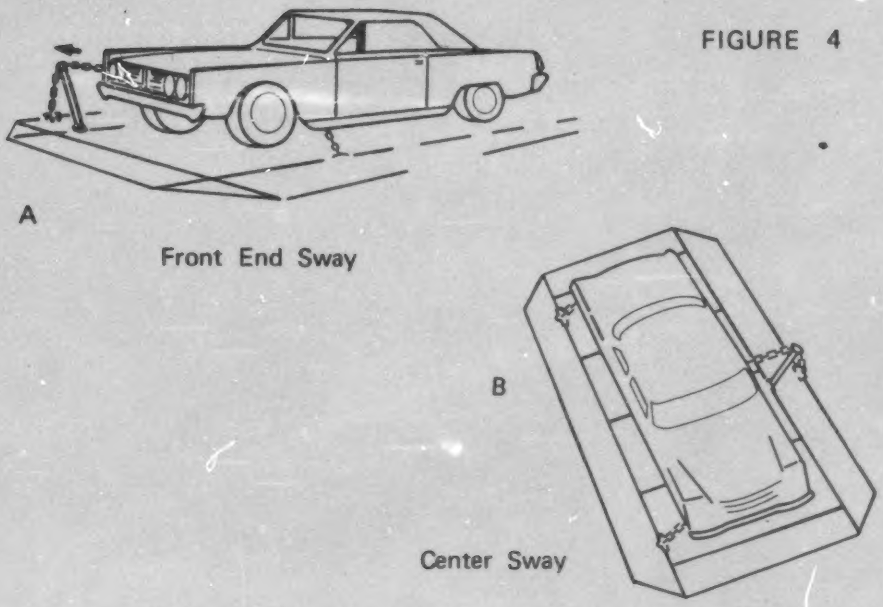


FIGURE 4

A

Front End Sway

B

Center Sway

C. Pull frame rail

(CAUTION: Check all chains for weak links, check anchor and pull points for strength, and do not stand in the plane of the pulling force. Always stand to the side and away from the vehicle when operating frame pulling units.)

(IMPORTANT: When side rail stops moving, do not try to force it to move by applying more pressure as damage to the frame by tearing or collapsing the frame rail will result. Always check pull and anchor points during this operation. Changing pull and anchor points is usually necessary during any frame repair to meet the needs of frame correction desired with each separate pull.)

D. Gauge frame

1. All pointers should align

2. All gauge bars should be parallel with the datum line and each other

3. Check with frame dimension charts

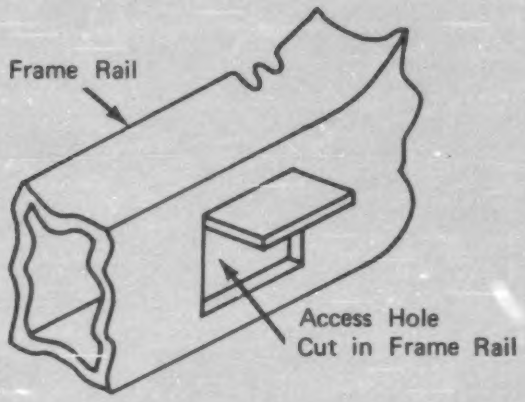
JOB SHEET #4

E. Finish straightening damaged frame rails

1. Straighten frame through access holes in side rails

2. Cut access holes if necessary and straighten rail (Figure 5)

FIGURE 5


Frame Rail
Access Hole
Cut in Frame Rail

3. Weld the cut access hole shut

4. Undercoat repair area

FRAME ALIGNMENT
UNIT II

JOB SHEET #5--STRAIGHTEN AND ALIGN DIAMOND FRAME DAMAGE

I. Tools and equipment

A. Bumping hammer

B. Dolly blocks

C. Finishing hammer

D. Hydraulic jack set--10 ton

E. Hydraulic jack (hand)

F. Frame machine (portable or stationary)

G. Oxyacetylene torch

H. AC or DC welding unit

I. Welding rod

J. Measuring tape

K. Self-centering gauges

L. Tram gauge

M. Frame dimension charts

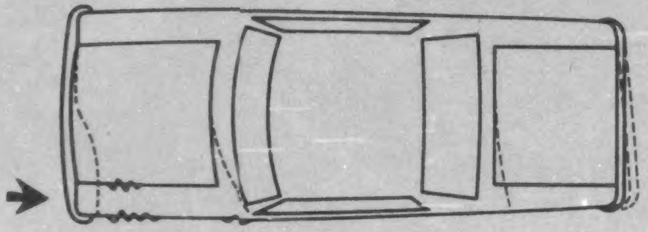
JOB SHEET #5

II. Procedure

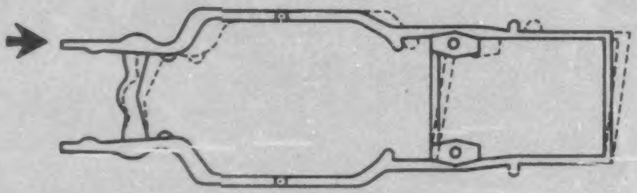
A. Analyze the damage

1. Determine the extent of damage
2. Determine what parts must be removed to gain access to pull points (Figure 1)

FIGURE 1



Diamond is caused by an off-center head-on impact.



The damage will extend the full length of the car because one rail has been moved rearward.

(NOTE: It is always better to perform pulls with body parts intact to help correct alignment of the body section of the automobile.)

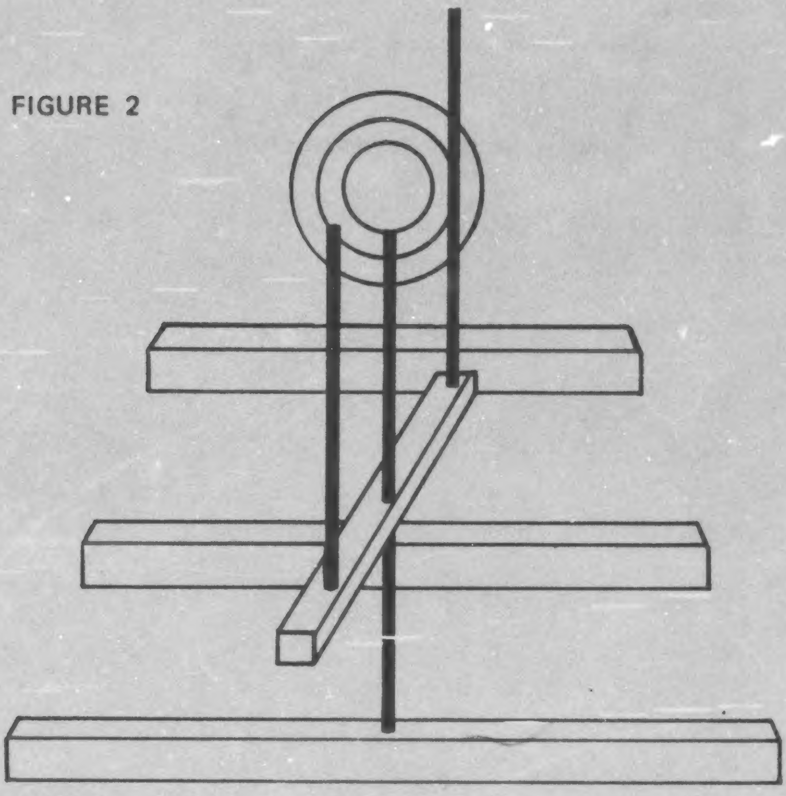
JOB SHEET #5

B. Set up frame equipment to correct damage

1. Place automobile on safety stands to get desired height

2. Gauge frame to determine damage (Figure 2)

FIGURE 2



Self-Adjusting Frame Gauge

a. In the diamond situation, gauge will be parallel to datum line and to each other and indicator holes will line up; therefore, a diamond detector attachment must be used on center gauge to show diamond frame damage

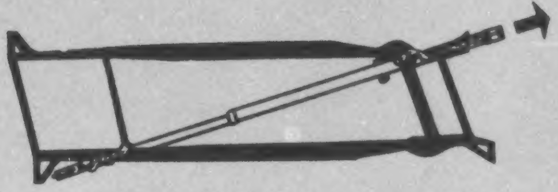
b. Diagonal measurement of the frame will also indicate diamond frame damage

JOB SHEET #5

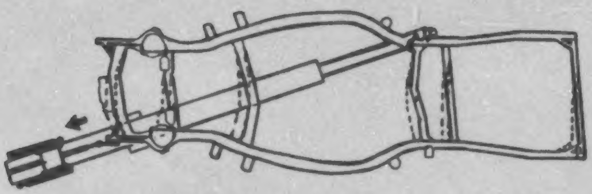
3. Place machine under diagonal, across frame as illustrated and anchor

   a. Portable (Figure 3)

FIGURE 3



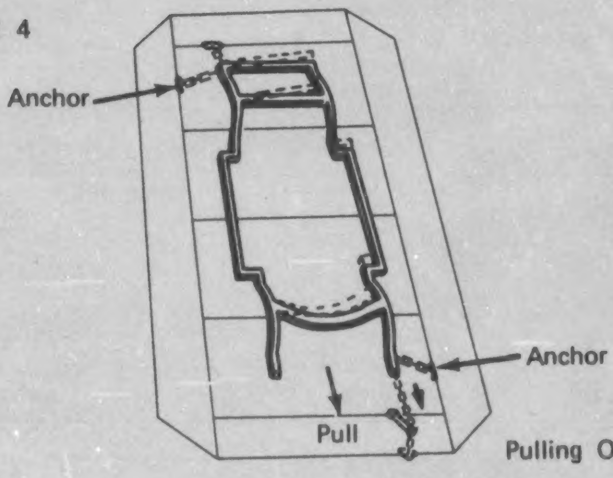
Ladder Frame



Perimeter Frame

   b. Stationary (Figure 4)

FIGURE 4



Pulling Out Diamond

JOB SHEET #5

C. Pull frame rail

(CAUTION: Check all chains for weak links, check anchor and pull points for strength, and do not stand in the plane of the pulling force. Always stand to the side and away from the vehicle when operating frame pulling units.

1. Measure with tram gauge or rule diagonally across frame

2. Check self-centering gauges to insure other types of frame damage have not resulted

   (NOTE: Mash type frame damage is common with diamond.)

3. Check frame dimension charts

D. Finish straightening frame rails

(NOTE: Unless combination damage has occurred, damage to the frame rails usually does not exist with diamond frame condition.)

FRAME ALIGNMENT
UNIT II

TEST

1. Match the terms on the right to the correct definition.

_____a. The side rails of the frame system which are tied together with cross members and braces to form the frame of an automobile

_____b. That portion of the frame ahead of the front cross member where the bumper bolts to the frame

_____c. Frame sections used to tie the two frame rails together to form the frame

_____d. Two flanges welded together along their edges; type construction found where the rocker panel welds to the floor pan

_____e. Frame straightening unit which can be moved from vehicle to vehicle to straighten the frame and body

_____f. Frame straightening system that is stationary and the vehicle must be placed on it for frame and body straightening purposes

_____g. Type of frame clamp where increased pressure makes the jaws of the clamp pull taut on the metal

_____h. Used to provide the anchor along pinchwelds; this type of clamp must be used with unit frame construction

_____i. A plate used to bolt to the frame providing a pull location where one is not available in the frame

1. Self-tightening clamp
2. Pull plate
3. Underbody clamp
4. Tracking
5. Multiple hookup
6. Frame horn
7. Dog tracking
8. Fish plating
9. Anchor
10. Pinch weld
11. Combination damage
12. Stationary frame unit
13. Frame rail
14. Cross member
15. Portable frame unit

_____j. Tie down points to hold the automobile when using frame straightening units

_____k. Performing several pulls at the same time

_____l. The rear wheels following the front wheels of an automobile properly

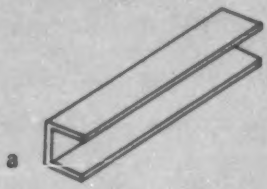
_____m. When the rear wheels do not follow the front wheels properly

_____n. Several types of frame damage occuring at the same time

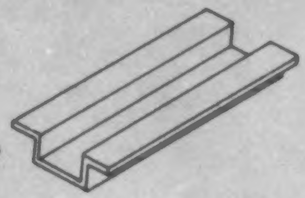
_____o. Strengthening a frame by welding, riveting, or bolting a plate or rail to it

2. Identify the six different shapes of frame rail and cross member construction.

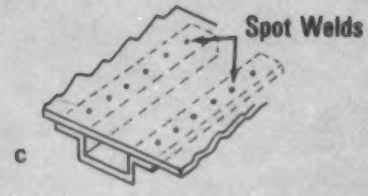
a.



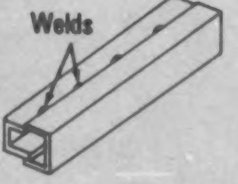
b.



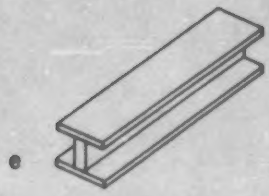
c.



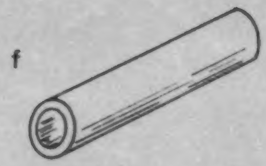
d.



e.



f.



3. List two uses of portable or fixed frame straightening units.

   a.

   b.

4. Name five types of frame and body straightening units.

   a.

   b.

   c.

   d.

   e.

5. Identify three basic hookups used in frame and body repair.

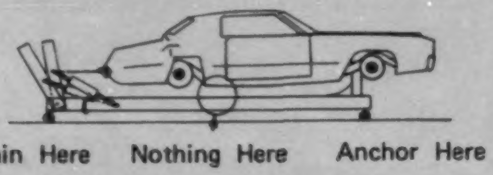
a.

b.

c.

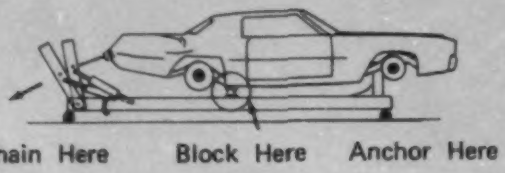
The corrective forces will always follow the direction of the chain as it first leaves the car.

a


Chain Here
Nothing Here
Anchor Here

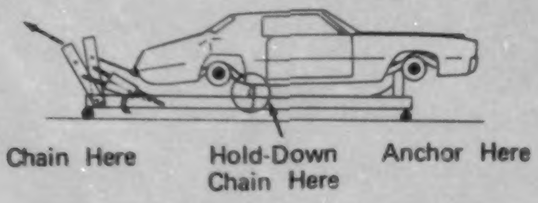
Corrective forces are again in line with the direction of the chain.

b


Chain Here
Block Here
Anchor Here

When the chain is pointed up, a hold-down chain is required to prevent entire car from raising.

c


Chain Here
Hold-Down Chain Here
Anchor Here

6. Describe the advantage of the fixed frame straightening unit over the portable frame straightening unit.

7. List three methods for frame and body straightening repair.

   a.

   b.

   c.

8. Name two conditions that must be repaired to prevent weakening in damaged frame members.

   a.

   b.

9. List the order of repair and checking sequence that should be followed when straightening a damaged frame.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

10. Describe how the anchor should be connected to a unitized frame.

11. State a rule for the heating of mild steel.

12. State a rule for the pulling limits of mild steel.

13. Demonstrate the ability to:

    a. Straighten and align mash frame damage.

    b. Straighten and align sag frame damage.

    c. Straighten and align twist frame damage.

    d. Straighten and align sway frame damage

    e. Straighten and align diamond frame damage.

    (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

FRAME ALIGNMENT
UNIT II

ANSWERS TO TEST

1. a. 13
   b. 6
   c. 14
   d. 10
   e. 15
   f. 12
   g. 1
   h. 3
   i. 2
   j. 9
   k. 5
   l. 4
   m. 7
   n. 11
   o. 8
2. a. Channel
   b. Open box
   c. Closed box
   d. Double boxed channel
   e. Beam
   f. Tubular
3. a. Straighten frames
   b. Straighten sheet metal

4. a. Rail with fixed vertical support
   b. Rail with swinging vertical support
   c. Stationary frame rack
   d. Stationary floor mount
   e. Vacuum mount
5. a. Pull and anchor
   b. Pull, block, and anchor
   c. Pull, hold down, and anchor
6. Control over the vehicle anchor points and unlimited pulls can be made
7. a. Straighten body separately from frame
   b. Straighten frame separately from body
   c. Straighten body and frame at same time
8. a. Wrinkles and buckles on the metal surface
   b. Tears and breaks
9. a. Weld all cracks, tears, and split seams
   b. Correct length (mash)
   c. Correct height (sag)
   d. Correct width
   e. Correct sidesway
   f. Correct twist
   g. Correct diamond
   h. Correct tracking
10. The anchor points on a unitized body are underbody clamps that are fastened to the pinch weld along the underside of the floor pan; be sure to fasten the clamp in direct line with the direction of pull to prevent tearing the metal
11. Do not heat mild body or frame steel beyond cherry red hot
12. Do not continue to pull mild steel after movement of metal parts or members has stopped
13. Performance skills will be evaluated according to the criteria on the progress charts.

BUMPER AND PANEL ALIGNMENT
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with bumper and panel alignment, determine when welding and heating is necessary and follow the basic steps in doing repair work. He should be able to align bumpers and body panels for either straightening or replacement.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match a list of terms associated with bumper and panel alignment to definitions.
2. Tell when torn areas should be welded.
3. Tell when heat is necessary when aligning body panels.
4. Describe how buckles should be removed.
5. List five body parts that may need to be removed to get at the damage or pull points.
6. Describe the amount of pressure necessary to release stress in metal.
7. List five basic steps to follow when doing repair work.
8. Demonstrate the ability to:
    a. Align a bumper with ends pushed into the body.
    b. Align a bumper hit in the center.
    c. Align a bumper with ends pulled out.
    d. Align a damaged fender.
    e. Align a damaged cowl.
    f. Align a damaged door panel with vacuum equipment.
    g. Align side damage.
    h. Align a top.
    i. Align rear section damage.

BUMPER AND PANEL ALIGNMENT
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparency.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency master: TM 1--Setup

   D. Job sheets

      1. Job Sheet #1--Align a Bumper With Ends Pushed into the Body

      2. Job Sheet #2--Align a Bumper Hit in the Center

3. Job Sheet #3--Align a Bumper With Ends Pulled Out
4. Job Sheet #4--Align a Damaged Fender
5. Job Sheet #5--Align a Damaged Cowl
6. Job Sheet #6--Align a Damaged Door Panel With Vacuum Equipment
7. Job Sheet #7--Align Side Damage
8. Job Sheet #8--Align Top Damage
9. Job Sheet #9--Align Rear Section Damage

E. Test

F. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Company of Canada Limited, 1969.

B. McPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Book Company Inc., 1971.

C. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

D. Toboldt, Bill. *Autobody Repairing and Repainting.* Third Edition. South Holland, Illinois: Goodheart-Willcox Company, Inc., 1972.

E. *Repairing Frame and Unitized Body Construction,* Technical Manual PM-301: Milwaukee, Wisconsin: Blackhawk Manufacturing Company, Division of Applied Power Industries, Inc.

F. *Repairing Collision Damage with the Modern Work Saving Korek Body and Frame Repair System,* Instruction Manual 15-169. Milwaukee, Wisconsin: Blackhawk Manufacturing Company, Division of Applied Power Industries, Inc.

G. *Guide to Profits Operating Manual.* Ontario, Canada: Greg-Chart Tools Limited.

H. *Kansas Jack Manual.* Tenth Edition. McPherson, Kansas: Kansas Jack Inc.

I. *John Bean Manual,* Lansing, Michigan: John Bean Division, FMC Corp.

BUMPER AND PANEL ALIGNMENT
UNIT III

INFORMATION SHEET

I. Terms and definitions (Transparency 1)

   A. Unitized body--Rigid, reinforced steel or box to which engine, power train, and running gear are attached

   B. Roughout--The alignment of damaged panels, inner panels, and parts prior to their replacement insuring that the new parts will properly fit

   C. Setup--The equipment when it is in place ready to use; each separate pull or push is a setup

   D. Hookup--Hooking the body and frame unit to the automobile by use of chains, clamps, or other attachments

   E. Body clamp--Any device used to provide a "hookup" point on the body or frame

   (NOTE: There are many different body clamps available for different hookups.)

II. Welding torn metal--Before any pulling or pushing is done

III. Aligning body panels with heat-Necessary only to keep from causing further damage and to help remove the crumpled areas

IV. Removing buckles--By heat or by hammering while tension is being applied

   (NOTE: Pulling alone will not remove buckles.)

V. Possible body parts to remove

   A. Hood

   B. Grill

   C. Bumpers

   D. Doors

   E. Deck lid

VI. Pressure necessary to release stress in metal--Pressure must be exerted to over correct the frame or body to allow for spring back when pressure is released

VII. Steps in repair work

   A. Locate the damage

   B. Plan the work

   C. Roughout the work

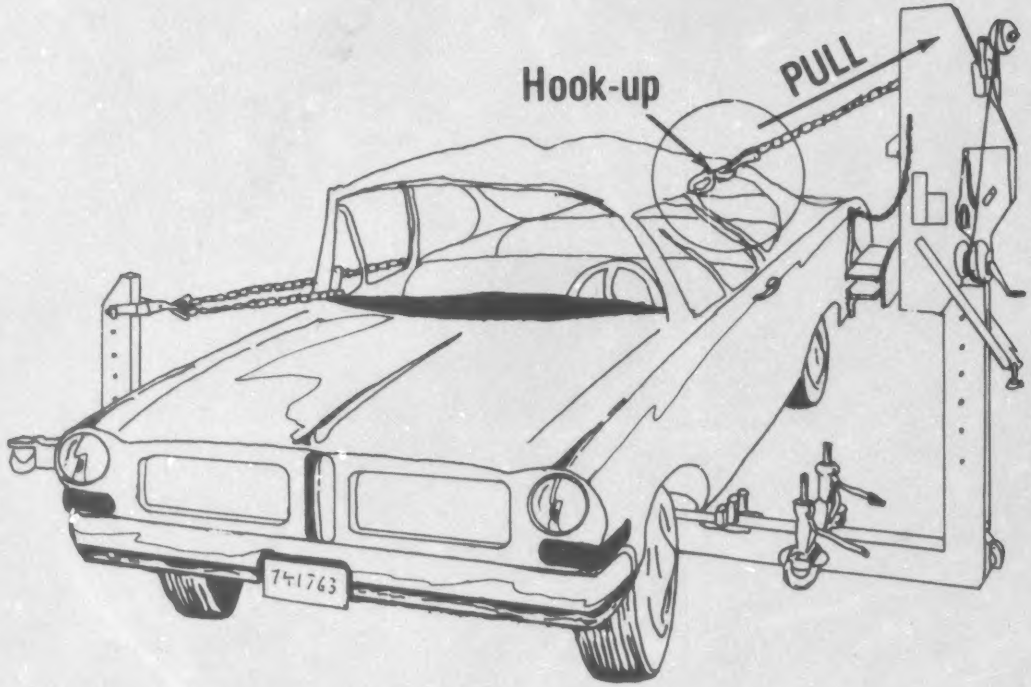
INFORMATION SHEET

D. Check the work

E. Straighten or replace panels

(NOTE: A thorough knowledge of body construction and proper techniques of body repair are necessary when doing repair work.)

Setup


Hook-up
PULL
741763

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #1--ALIGN A BUMPER WITH ENDS PUSHED INTO THE BODY

I. Tools and equipment

   A. Bumping hammers

   B. Pry bars

   C. Body spoons

   D. Panel cutter

   E. Dolly blocks

   F. Socket set--3/8" drive, 3/8" through 7/8"

   G. Combination end wrench set--3/8" through 7/8"

   H. Lift jack and safety stands

   I. Complete body and frame straightening unit with pull clamps, gauges, and other equipment

   K. Oxyacetylene unit

II. Procedure

   A. Analyze the damaged bumper (Figure 1 on next page)

   (DANGER: On energy absorbing bumpers, check procedures in service manual before removing bumper as inclosed high tension spring could cause death or bodily injury.)

      1. Determine if it will be straightened

      2. Determine if it will be replaced

   (NOTE: The vehicle estimate will usually provide information as to whether a part is repaired or replaced. However, many times braces, brackets, and interior panels are not replaced and need to be repaired. It is always better to pull and straighten them on the damaged parts before they are removed if it is possible to do so.)

   (NOTE: When straightening damaged body parts, keep in mind that almost all damaged parts can be repaired. Cost is the factor that usually determines replacement over repair.)

JOB SHEET #1

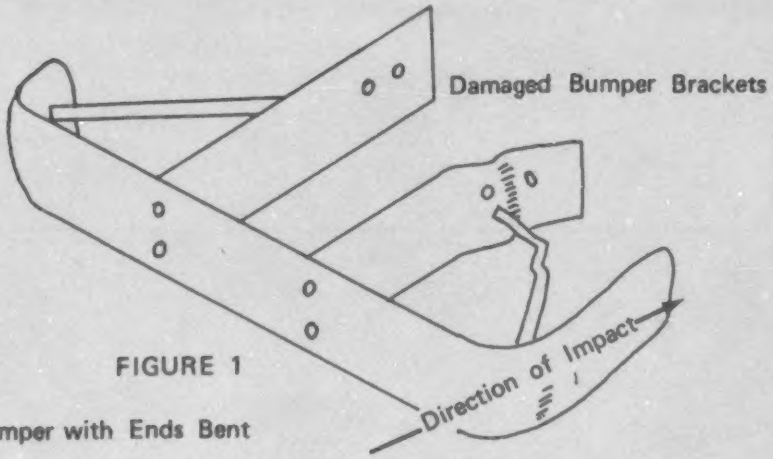

Damaged Bumper Brackets
Direction of Impact

FIGURE 1

Bumper with Ends Bent

B. Set up pull unit (Figure 2)

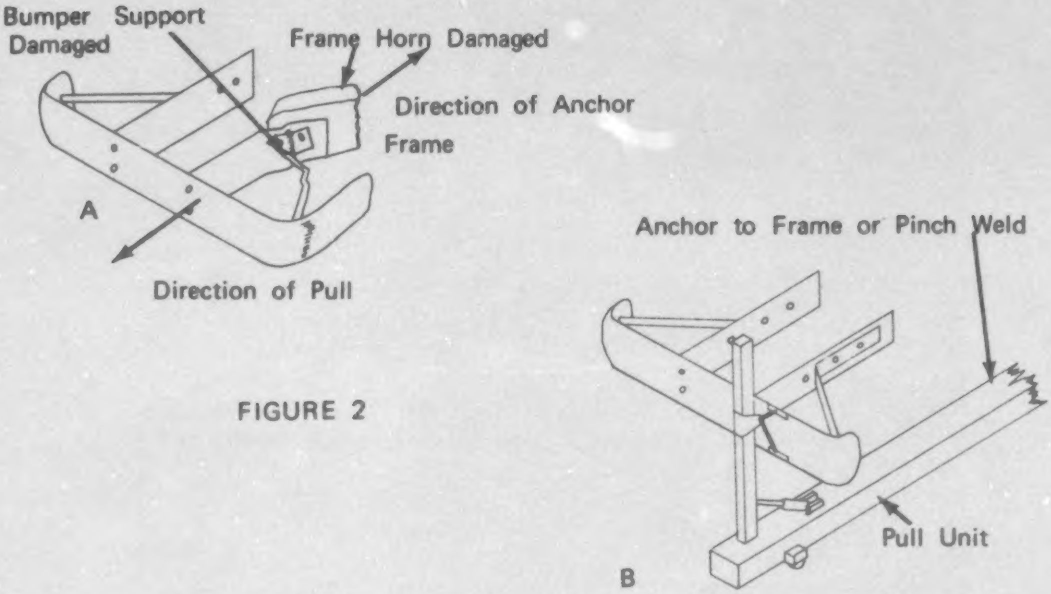

Bumper Support Damaged
Frame Horn Damaged
Direction of Anchor
Frame
A
Direction of Pull
Anchor to Frame or Pinch Weld
Pull Unit
B

FIGURE 2

1. Anchor the vehicle to the unit
2. Attached pull unit to bumper with chain and clamps

(NOTE: Pull unit should be set up to pull in a direct line with line of correction.)

JOB SHEET #1

C. Pull bumper

1. If top is twisted down, pull from top only
2. If bottom is twisted up, pull from bottom only
3. If damage is straight back, pull from both edges

(CAUTION: Be sure all chains (links and hooks) are in good condition and properly attached to the damaged part. Do not stand in the plane of the pulling directions. Stand to the side and away from the vehicle.)

D. Straighten damaged parts

1. With tension provided by the pull equipment, hammer creases down on the face of the bumper
2. Straighten brackets and weld if necessary
3. Straighten frame horns if damaged
4. Release tension
5. Repeat above procedure until bumper and attaching parts are aligned and straight

(NOTE: Alignment of damaged parts is necessary to insure that attaching brackets, braces, inner body panels, connecting body panels, and other parts will line up with the new replacement parts After a panel has been removed, it is very difficult to align damaged inner parts to new panels and parts.)

E. Remove and replace parts if required

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #2--ALIGN A BUMPER HIT IN THE CENTER

I. Tools and equipment

   A. Bumping hammers

   B. Pry bars

   C. Body spoons

   D. Panel cutter

   E. Dolly blocks

   F. Socket set--3/8" drive, 3/8" through 7/8"

   G. Combination end wrench set--3/8" through 7/8"

   H. Lift jack and safety stands

   I. Complete body and frame straightening unit with pull clamps, gauges, and other equipment

   J. Oxyacetylene unit

II. Procedure

   A. Analyze the damaged bumper

   (DANGER: On energy absorbing bumpers, check procedures in service manual before removing bumper as inclosed high tension spring could cause death or bodily injury.)

      1. Determine if it will be straightened

JOB SHEET #2

2. Determine if it will be replaced (Figure 1)

(NOTE: The vehicle estimate will usually provide information as to whether a part is repaired or replaced. However, many times braces, brackets, and interior panels are not replaced and need to be repaired. It is always better to pull and straighten them on the damaged parts before they are removed if it is possible to do so.)

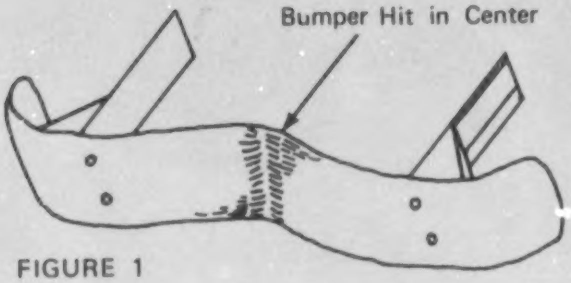


FIGURE 1

(NOTE: When straightening damage body parts, keep in mind that almost all damage parts can be repaired. Cost is the factor that usually determines replacement over repair.)

B. Set up pull unit (Figure 2)

1. Anchor the vehicle to the unit

2. Attached pull unit to bumper with chain and clamps

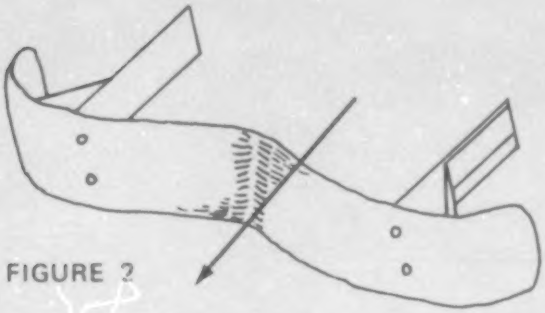


FIGURE 2

(NOTE: Pull unit should be set up to pull in a direct line with line of correction.)

JOB SHEET #2

C. Pull bumper

   1. Pull from both top and bottom edge using clamps

   2. If bumper is going to be replaced, drill hole in center and use eye bolt attachment

   (CAUTION: Be sure all chains (links and hooks) are in good condition and properly attached to the damaged part. Do not stand in the plane of the pulling directions. Stand to the side and away from the vehicle.)

D. Straighten damaged parts

   1. With tension still applied

      a. Straighten brackets

      b. Straighten frame horns

      c. Release tnesion

   2. Repeat above procedure until bumper and attaching parts are aligned and straight

   (NOTE: Alignment of damage parts is necessary to insure that attaching brackets, braces, inner body panels, connecting body panels, and other parts will line up with the new replacement parts. After a panel has been removed, it is very difficult to align damaged inner parts to new panels and parts.)

E. Remove and replace parts if required

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #2-ALIGN A BUMPER WITH BODY PULLER UNIT

I. Tools and equipment

  A. Bumping hammers

  B. Pry bars

  C. Body spoons

  D. Panel cutter

  E. Dolly blocks

  F. Socket set-3/8" drive, 3/8" through 7/8"

  G. Combination end wrench set--3/8" through 7/8"

  H. Lift jack and safety stands

  I. Complete body and frame straightening unit with pull clamps, gauges, and other equipment

  J. Oxyacetylene unit

II. Procedure

  A. Analyze the damaged bumper (Figure 1 on next page)

  (DANGER: On energy absorbing bumpers, check procedures in service manual before removing bumper as inclosed high tension spring could cause death or bodily injury.)

    1. Determine if it will be straightened

JOB SHEET #3

2. Determine if it will be replaced

(NOTE: The vehicle estimate will usually provide information as to whether a part is repaired or replaced. However, many times braces, brackets, and interior panels are not replaced and need to be repaired. It is always better to pull and straighten them on the damaged parts before they are removed if it is possible to do so.)

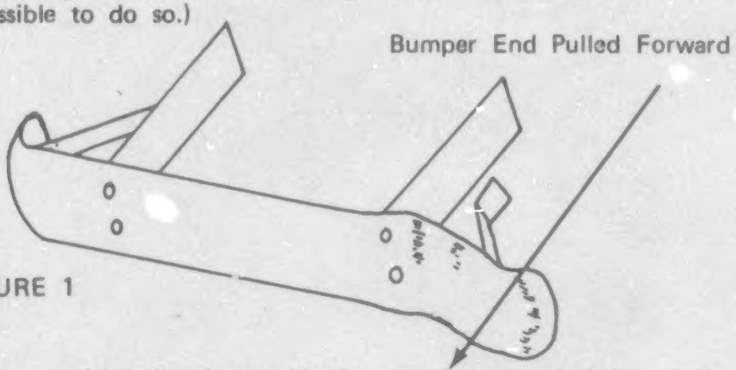

Bumper End Pulled Forward

FIGURE 1

(NOTE: When straightening damaged body parts, keep in mind that almost all damaged parts can be repaired. Cost is the factor that usually determines replacement over repair.)

B. Remove damage bumper brackets

(NOTE: Do not remove the main bumper bracket, only end braces, etc.)

C. Set up portable frame unit for push position (Figure 2)

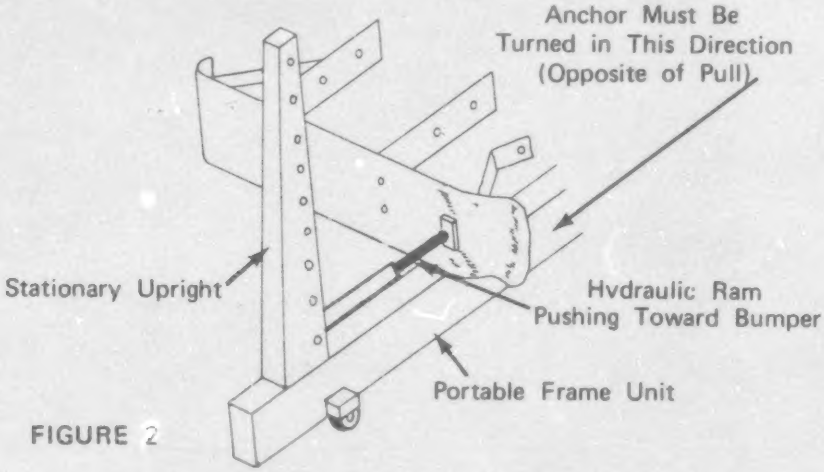

Anchor Must Be Turned in This Direction (Opposite of Pull)
Stationary Upright
Hydraulic Ram Pushing Toward Bumper
Portable Frame Unit

FIGURE 2

JOB SHEET #3

D. Push bumper back in place

1. Check bumper brackets during pushing operation to be sure brackets do not bend back too far creating mash condition
2. Using roughing hammer, straighten buckles in the top and bottom edge of the bumper
3. Push a little beyond straight condition to allow for elasticity of the bumper

(CAUTION: Be sure all chains (links and hooks) are in good condition and properly attached to the damaged part. Do not stand in the plane of the pulling directions. Stand to the side and away from the vehicle.)

E. Straighten damaged parts

1. Straighten damaged brackets and braces
2. Re-install removed items to insure proper fit

(NOTE: Alignment of damaged parts is necessary to insure that attaching brackets, braces, inner body panels, connecting body panels and other parts will line up with the new replacement parts. After a panel has been removed, it is very difficult to align damaged inner parts to new panels and parts.)

F. Remove and replace parts if required

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #4--ALIGN A DAMAGED FENDER

I. Tools and equipment

  A. Bumping hammers

  B. Pry bars

  C. Body spoons

  D. Panel cutter

  E. Dolly blocks

  F. Socket set--3/8" drive, 3/8" through 7/8"

  G. Combination end wrench set--3/8" through 7/8"

  H. Lift jack and safety stands

  I. Complete body and frame straightening unit with pull clamps, gauges, and other equipment

  K. Oxyacetylene unit

JOB SHEET #4

II. Procedure

A. Analyze the damaged fender (Figure 1)

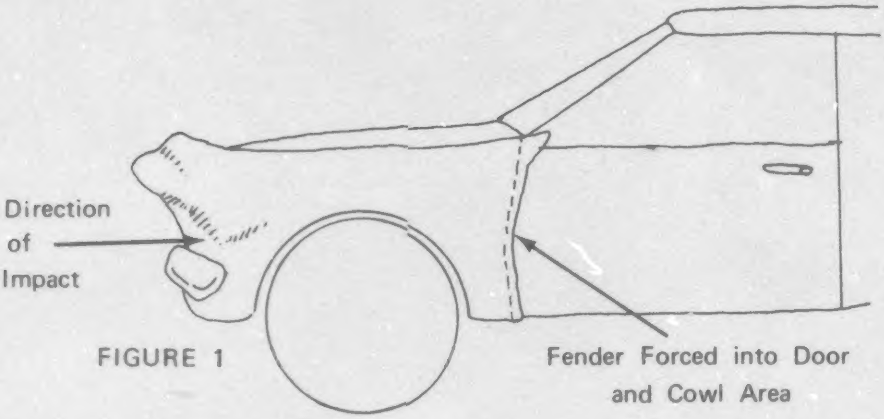


FIGURE 1

1. Determine if it will be straightened or replaced

   (NOTE: Check estimate.)

2. Determine what repairs must be made on other body parts

   a. Bumper

   b. Braces and brackets

   c. Frame

B. Place automobile on jack safety stand and remove wheel

(CAUTION: Set stands in safe and proper points.)

C. Pull bumper to its proper position and remove

(DANGER: On energy absorbing bumpers, check procedures in service manual before removing bumper as inclosed high tension spring could cause death or bodily injury.)

JOB SHEET #4

D, Hook portable frame and body unit to fender (Figure 2)

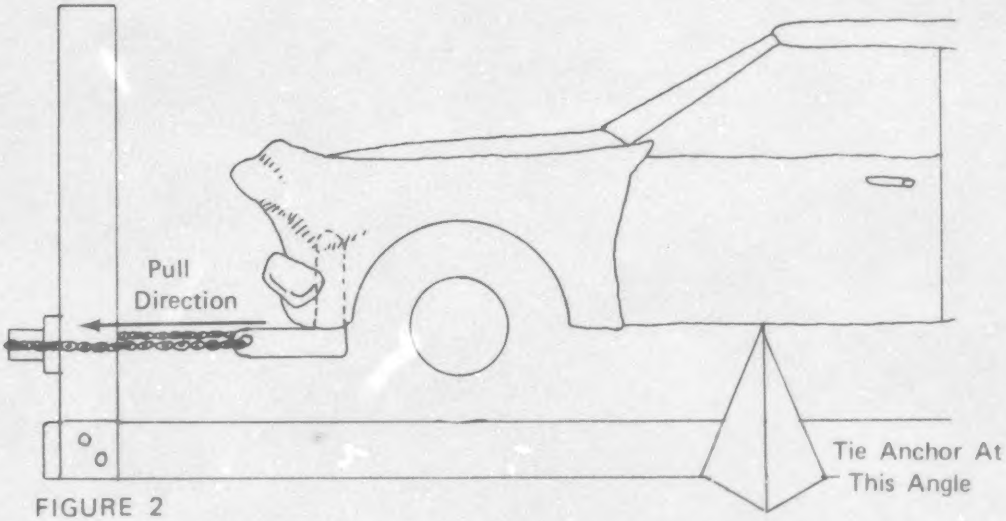


FIGURE 2

(NOTE: There are many various clamps, hooks, and tie bars available for hooking to various body panels. Use the one that is appropriate for each job or pull.)

(CAUTION: Be sure all chains (links and hooks) are in good condition and properly attached to the damaged part. Do not stand in the plane of the pulling directions. Stand to the side and away from the vehicle.)

1. Pull fender forward

   a. Relieve buckles in outer fender and inner skirt as pull proceeds

      (NOTE: Do not try to pull fender in one operation. It is necessary to relieve tension and strain in the metal during the pulling operation. If this is not done, the metal will be damaged by work harding, stretching, and tearing. Check with your instructor.)

   b. Check alignment at cowl and door area

      1. Pull beyond correct alignment (3/16" +- 1/8") because of elasticity of braces and brackets

      2. Check body bolts and repair any damage present

JOB SHEET #4

2. Release tension and repeat procedure if fender is not in correct position

E. Straighten or replace according to estimate

(NOTE: Several different pull angles and hookups may be necessary to align the fender to its correct position. The pull procedure is determined by the direction of damage. In combination damage, several pulls will be necessary or use multiple hookups if equipment is available. Always check with your instructor before making a pull.)

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #5--ALIGN A DAMAGED COWL

I. Tools and equipment

A. Bumping hammers

B. Pry bars

C. Body spoons

D. Panel cutter

E. Dolly blocks

F. Socket set--3/8" drive, 3/8" through 7/8"

G. Combination end wrench set--3/8" through 7/8"

H. Lift jack and safety stands

I. Complete body and frame straightening unit with pull clamps, gauges, and other equipment

K. Oxyacetylene unit

II. Procedure

A. Analyze the damaged cowl (Figure 1)

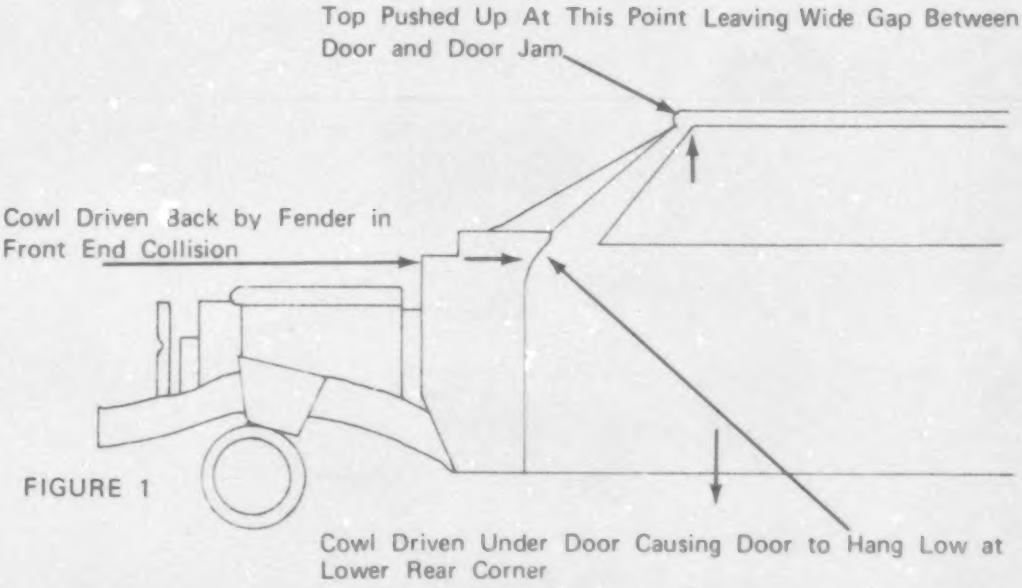

Top Pushed Up At This Point Leaving Wide Gap Between Door and Door Jam
Cowl Driven Back by Fender in Front End Collision
Cowl Driven Under Door Causing Door to Hang Low at Lower Rear Corner

FIGURE 1

JOB SHEET #5

B. Determine method of repair

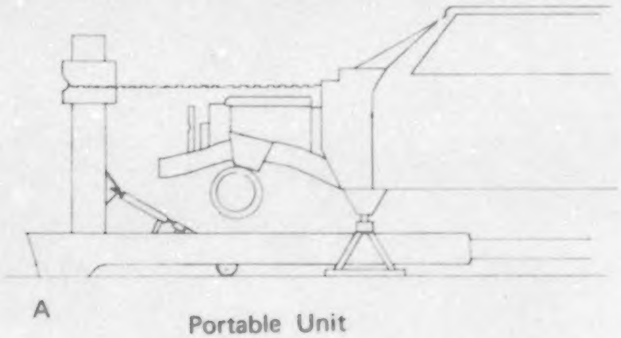
(NOTE: Check estimate.)

C. Place automobile on jack safety stand and remove wheel

(CAUTION: Set safety stands at safe and proper points.)

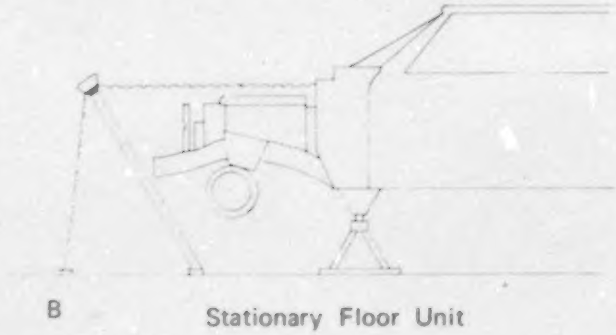
D. Hook up frame and body unit (Figure 2)

(NOTE: There are many types of clamps, hooks, and tie bars available for hooking to various body panels. Use the one that is appropriate for each job or pull.)



Portable Unit

FIGURE 2



Stationary Floor Unit

(CAUTION: Be sure all chains (links and hooks) are in good condition and properly attached to the damaged part. Do not stand in the plane of the pulling direction. Stand to the side and away from the vehicle.)

JOB SHEET #5

E. Pull cowl forward

1. Force top back into position with bumping hammer and block

2. Remove strain on floor pan using body spoon in lower door jam (Figure 3)

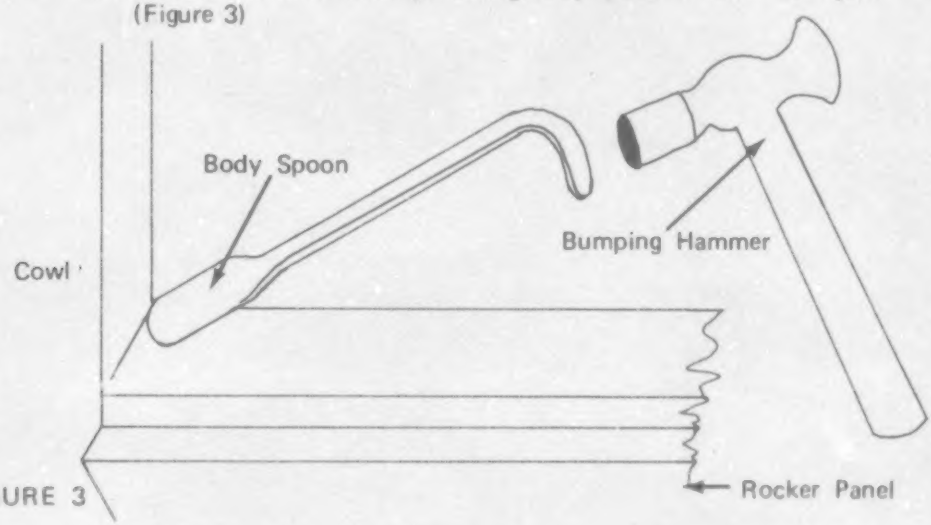

Body Spoon
Cowl
Bumping Hammer
Rocker Panel

FIGURE 3

3. Align area where windshield header joins the top of the cowl with body spoon (Figure 4)

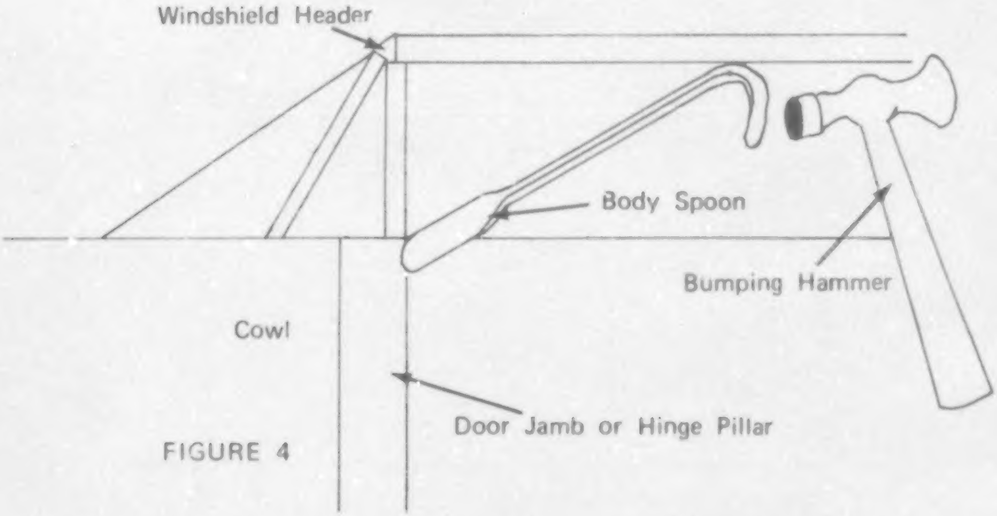

Windshield Header
Body Spoon
Bumping Hammer
Cowl
Door Jamb or Hinge Pillar

FIGURE 4

JOB SHEET #5

4. Pull cowl beyond correct alignment because of elasticity

5. Weld any cracks or breaks in body joints that are a result of the pulling

F. Release tension

G. Repeat the above procedure if necessary

H. Straighten faces of panel if necessary

(NOTE: Several different pulls and hookups may be necessary to align the cowl. The pull procedure is determined by the direction of damage. In combination damage, several pulls will be necessary or use multiple hookups if equipment is available. Always check with your instructor before making a pull.)

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #6--ALIGN A DAMAGED DOOR PANEL WITH VACUUM EQUIPMENT

I. Tools and equipment

   A. Bumping hammers

   B. Pry bars

   C. Body spoons

   D. Panel cutter

   E. Dolly blocks

   F. Socket set--3/8" drive, 3/8" through 7/8"

   G. Combination end wrench set-3/8" through 7/8"

   H. Lift jack and safety stands

   I. Complete body and frame straightening vacuum unit with pull clamps, gauges, and other equipment

   J. Oxyacetylene unit

II. Procedure

   A. Analyze the damaged door (Figure 1)

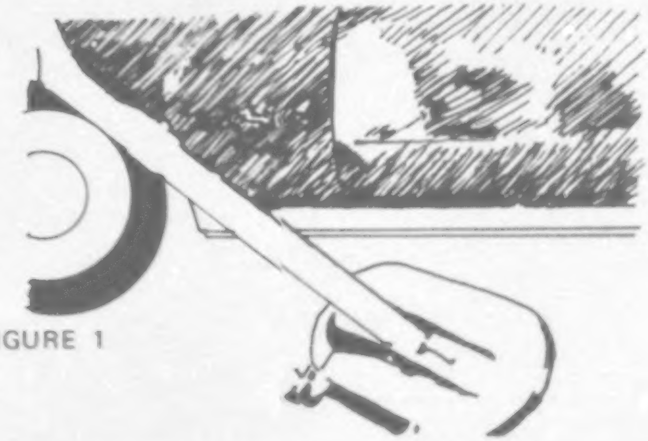


FIGURE 1

JOB SHEET #6

B. Hook portable vacuum post to the door

1. Set post two or three feet from door
2. Attach vacuum hookup to door (Figure 2)

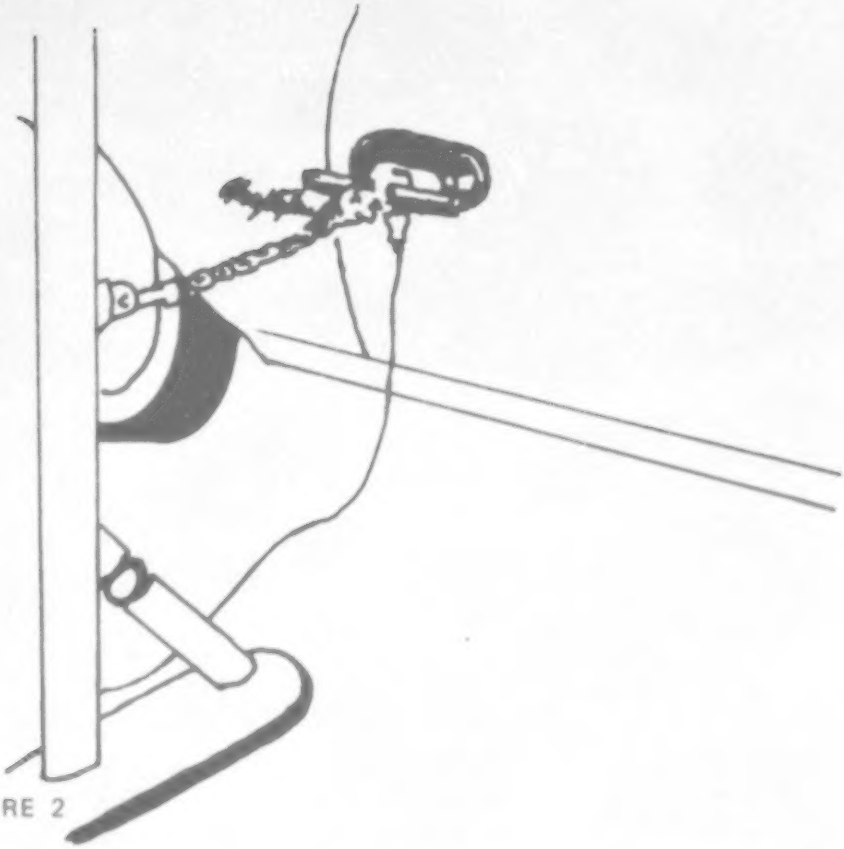


FIGURE 2

C. Pull door

1. Apply tension to the door using the pull post

   (CAUTION: Be sure all chains (links and hooks) are in good condition and properly attached to the damaged post. Do not stand in the plane of the pulling force. Stand to the side and away from the vehicle.)

JOB SHEET #6

2. Spoon panel or use body hammer while pull is being made to relieve stress and tension in the door panel (Figure 3)

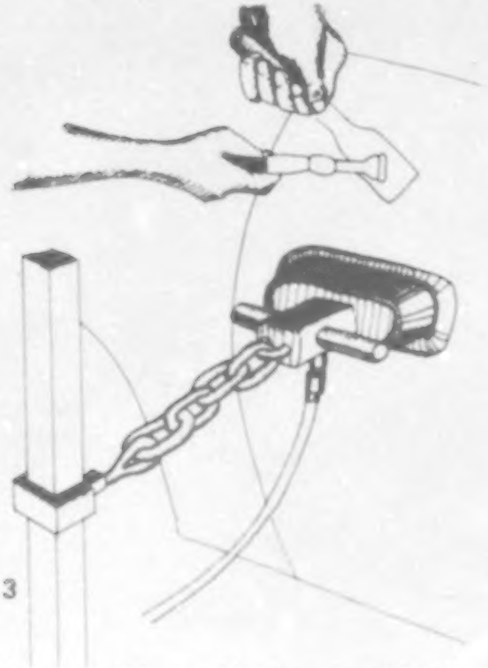
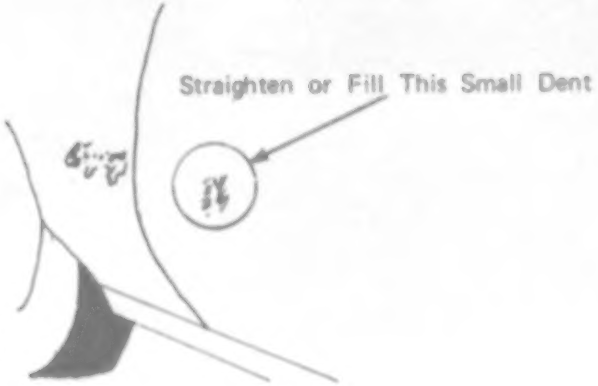


FIGURE 3

E. Straighten damage left in panel by hammer and dolly or by filling techniques (Figure 4)



Straighten or Fill This Small Dent

FIGURE 4

(NOTE: This type of repair may be used on any panel, door fender, quarter panel, or other parts where the metal damage is being held by stress and not sharp creases and bends.)

(IMPORTANT: Always check with the instructor before making a pull.)

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #7--ALIGN SIDE DAMAGE

I. Tools and equipment

   A. Bumping hammers

   B. Pry bars

   C. Body spoons

   D. Panel cutter

   E. Dolly blocks

   F. Socket set--3/8" drive, 3/8" through 7/8"

   G. Combination end wrench set--3/8" through 7/8"

   H. Lift jack and safety stands

   I. Complete body and frame straightening unit with pull clamps, gauges, and other equipment

   J. Oxyacetylene unit

II. Procedure

   A. Analyze the damaged rocker panel and floor section (Figure 1)

      1. Determine frame damage (sidesway)

      2. Determine post damage

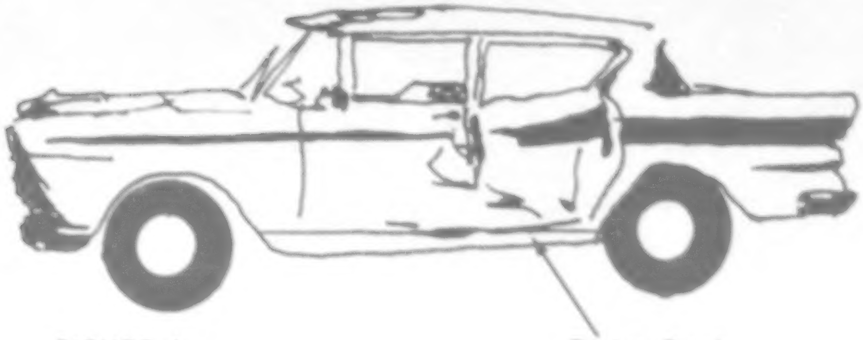


FIGURE 1

JOB SHEET #7

B. Set up pulling unit for repair (Figure 2)

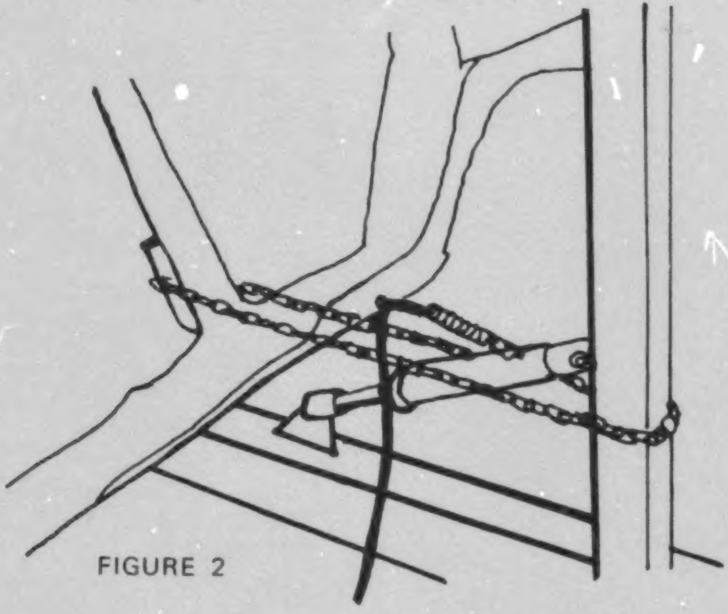


FIGURE 2

1. Remove doors if necessary
2. Remove necessary interior trim and hardware

(CAUTION: Check all chain (links and hooks) before pulling. Do not stand in the plane of pull. Stand to the side and away from the automobile.)

C. Pull post (Figure 3)

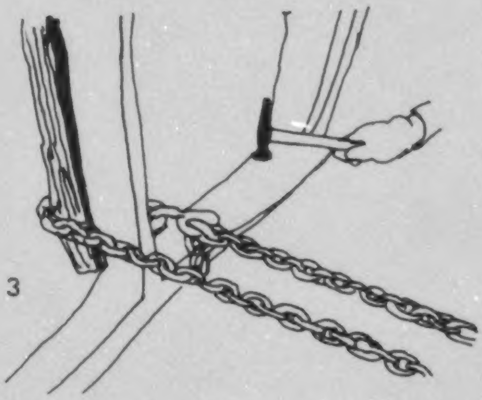


FIGURE 3

JOB SHEET #7

1. Relieve strain using hammer, spoon, or other tools
2. Heat buckles in the floor to relieve tension and strain
3. Continue pulling until post is in proper alignment

D. Pull rocker panel (Figure 4)

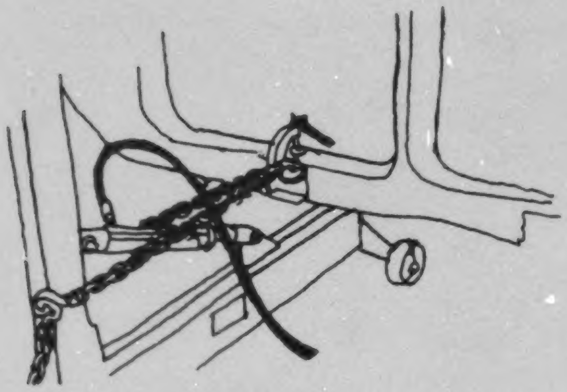


FIGURE 4

1. Work from most severe damage to the least severe until proper alignment has been accomplished.
2. Pull post again, if necessary, to obtain proper alignment of rocker panel, post, and floor pan

   (NOTE: Many types of clamps and pull connections are available. Use the ones that work best and do the least amount of damage to the panels.)

E. Check door openings

1. Measure using information from opposite doors if they are not damaged
2. Set doors in openings to see if alignment is proper

JOB SHEET #7

F. Straighten or replace as necessary

1. Doors
2. Center post
3. Rocker panel
4. Floor sections

(IMPORTANT: Always check with your instructor before making a pull.)

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #8--ALIGN TOP DAMAGE

I. Tools and equipment

  A. Bumping hammers

  B. Pry bars

  C. Body spoons

  D. Panel cutter

  E. Dolly blocks

  F. Socket set--3/8" drive, 3/8" through 7/8"

  G. Combination end wrench set--3/8" through 7/8"

  H. Lift jack and safety stands

  I. Complete body and frame straightening unit with pull clamps, gauges, and other equipment

  J. Oxyacetylene unit

II. Procedure

  A. Analyze the damage to the top

  (NOTE: When straightening or replacing a top, all rails, back glass and windshield headers, posts, and inner construction must be straightened and aligned before the top panel is straightened or replaced.)

    1. Side rail damage

    2. Windshield or back window header damage

    3. Inner support damage

    4. Check glass openings for squareness

  B. Determine method of repair

    1. Repair height

    2. Repair length

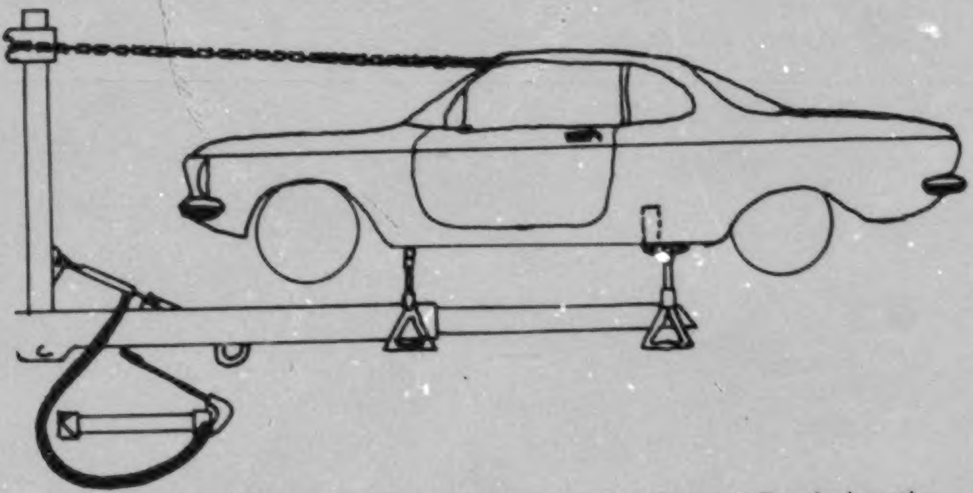
    3. Repair width

    4. Repair inner supports

JOB SHEET #8

C. Hook up frame and body repair unit

1. Windshield or back window header hookup (Figure 1)



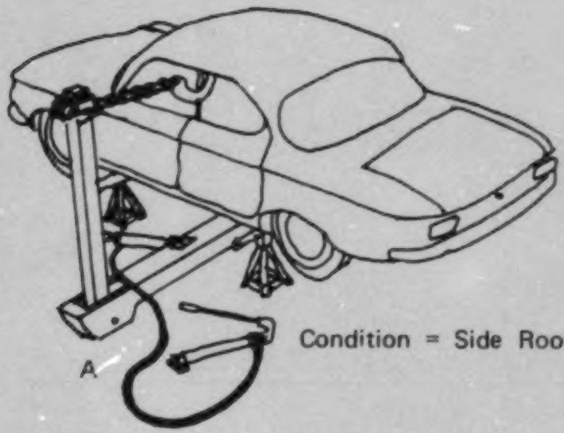
Condition = Front Roof Rail or Backwindow Header Damage--Repair Length

FIGURE 1

(NOTE: Other types of frame and body units can be used. The principle is still the same. Pull in the direction necessary to align the damaged headers.)

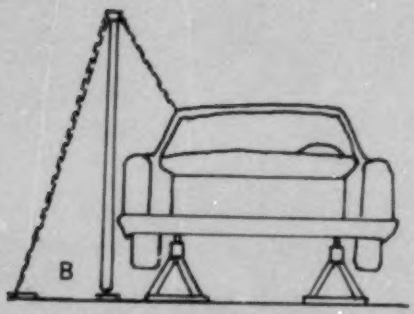
JOB SHEET #8

2. Side rail hookups (Figure 2)

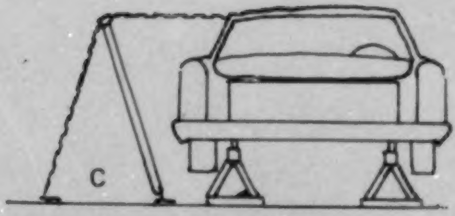


Condition = Side Roof Rail Damaged

FIGURE 2



For Pulling Roof Damage Up and Out, the Ram Strut is Positioned Higher Than the Roof Area



To Pull At the Roof Line, Use Ram with Extension Tubes. Set-Up Shows a Horizontal Pull.

(NOTE: Various types of frame and body units can be used. Analyze the direction of pull that is necessary to correct the damage and align headers.)

JOB SHEET #8

3. Height hookups (Figure 3)

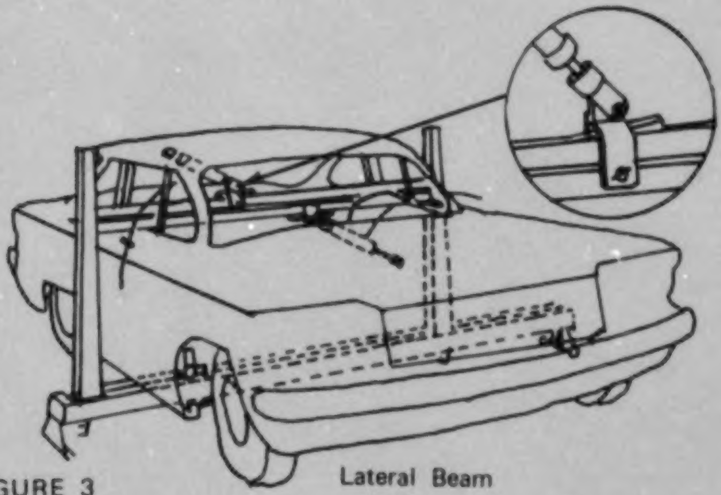


FIGURE 3

a. Provides all angle jacking bars

b. Allows for up, down, and sidesway correction (Figure 4)

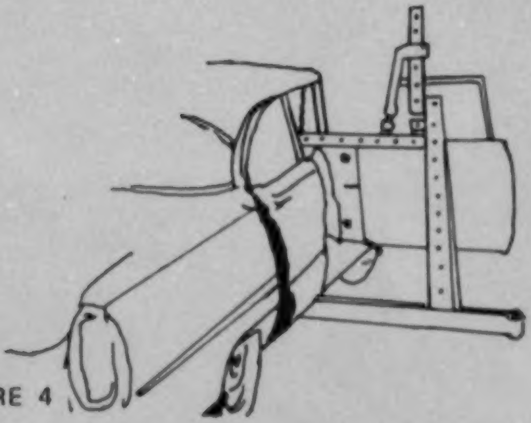


FIGURE 4

JOB SHEET #8

c. Post set up for downward pull

d. Reversing hydraulic cylinder will allow for upward push

D. Align top, roof rails, and windshield or backglass headers (Figure 5)

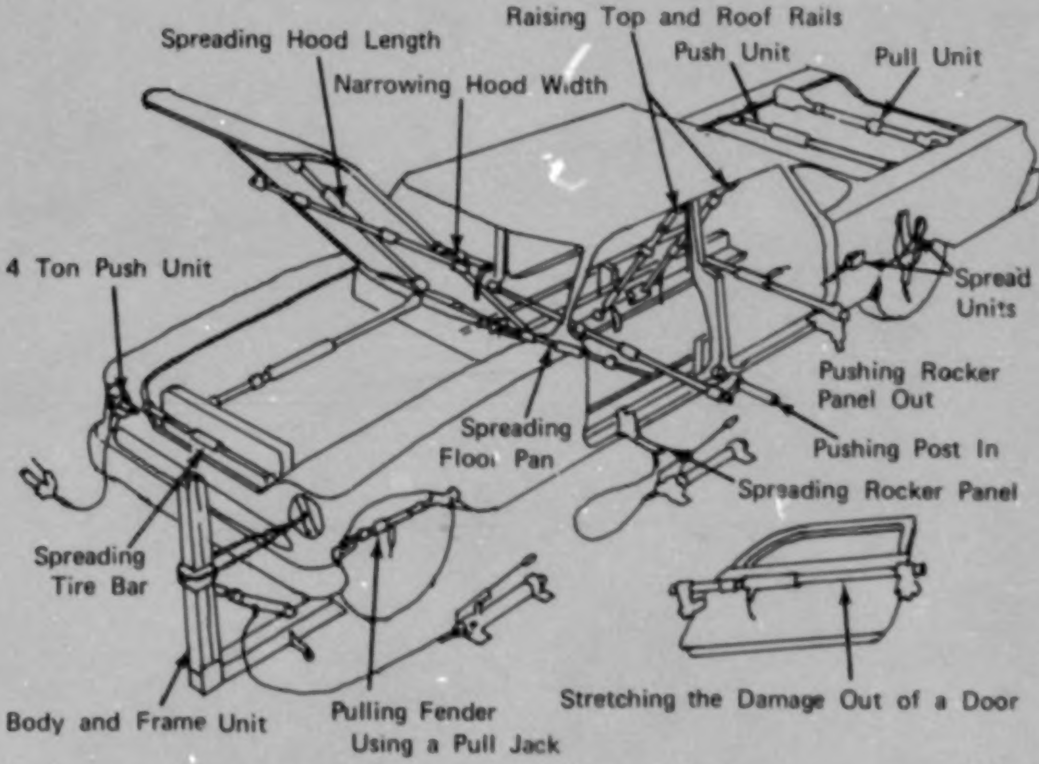

Raising Top and Roof Rails
Spreading Hood Length
Push Unit
Pull Unit
Narrowing Hood Width
4 Ton Push Unit
Spread Units
Pushing Rocker Panel Out
Spreading Floor Pan
Pushing Post In
Spreading Rocker Panel
Spreading Tire Bar
Body and Frame Unit
Pulling Fender Using a Pull Jack
Stretching the Damage Out of a Door

FIGURE 5

Various Hydraulic Jack Hook Ups and Pushes

(NOTE: The damage being repaired determines the types of push or pull and the types of equipment necessary. You may have to use only one form of correction or several to complete the alignment job. Work with your instructor when this type of damage is being repaired.)

1. Heat severly damaged areas (posts, headers, or others)

2. Weld all breaks or cracks that are a result of pulling

E. Straighten or replace roof panel as indicated by the estimate

(IMPORTANT: Always check with your instructor before making a pull.)

BUMPER AND PANEL ALIGNMENT
UNIT III

JOB SHEET #9--ALIGN REAR SECTION DAMAGE

I. Tools and equipment

A. Bumping hammers

B. Pry bars

C. Body spoons

D. Panel cutter

E. Dolly blocks

F. Socket set--3/8" drive, 3/8" through 7/8"

G. Combination end wrench set-3/8" through 7/8"

H. Lift jack and safety stands

I. Complete body and frame straightening unit with pull clamps, gauges, and other equipment

J. Oxyacetylene unit

II. Procedure

A. Analyze the damage to the quarter panels and rear body sections (Figures 1, 2, 3, and 4 on the following pages)

(NOTE: When straightening rear sections of the body, examine the frame and all related panels.)

1. Frame

2. Top

3. Quarter panel

4. Deck panel (upper and lower)

JOB SHEET #9

5. Floor pan and wheel housing

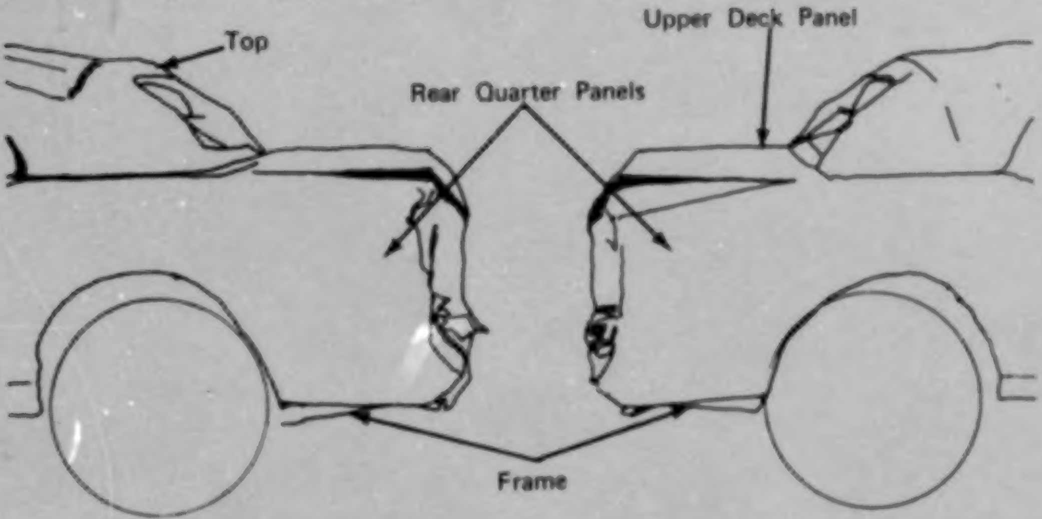

Top
Upper Deck Panel
Rear Quarter Panels
Frame

FIGURE 1

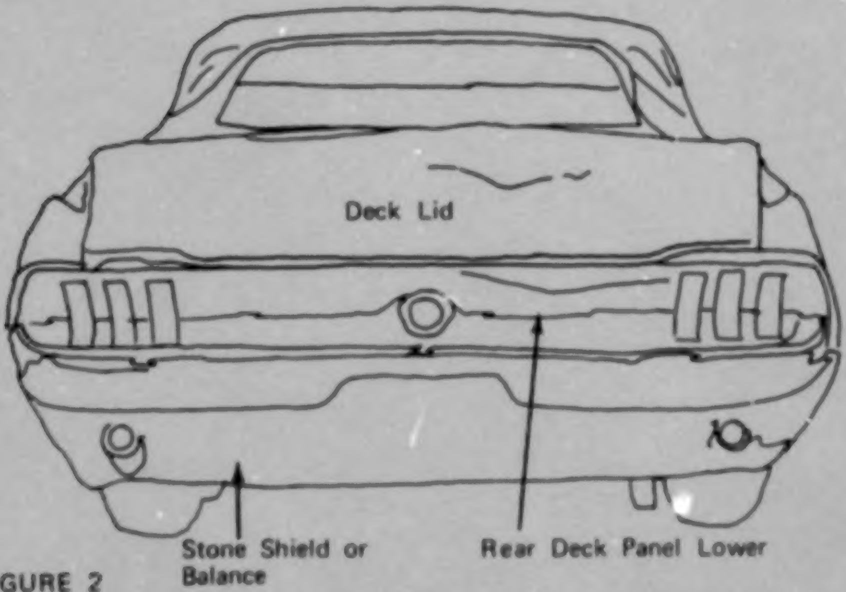

Deck Lid
Stone Shield or Balance
Rear Deck Panel Lower

FIGURE 2

JOB SHEET #9

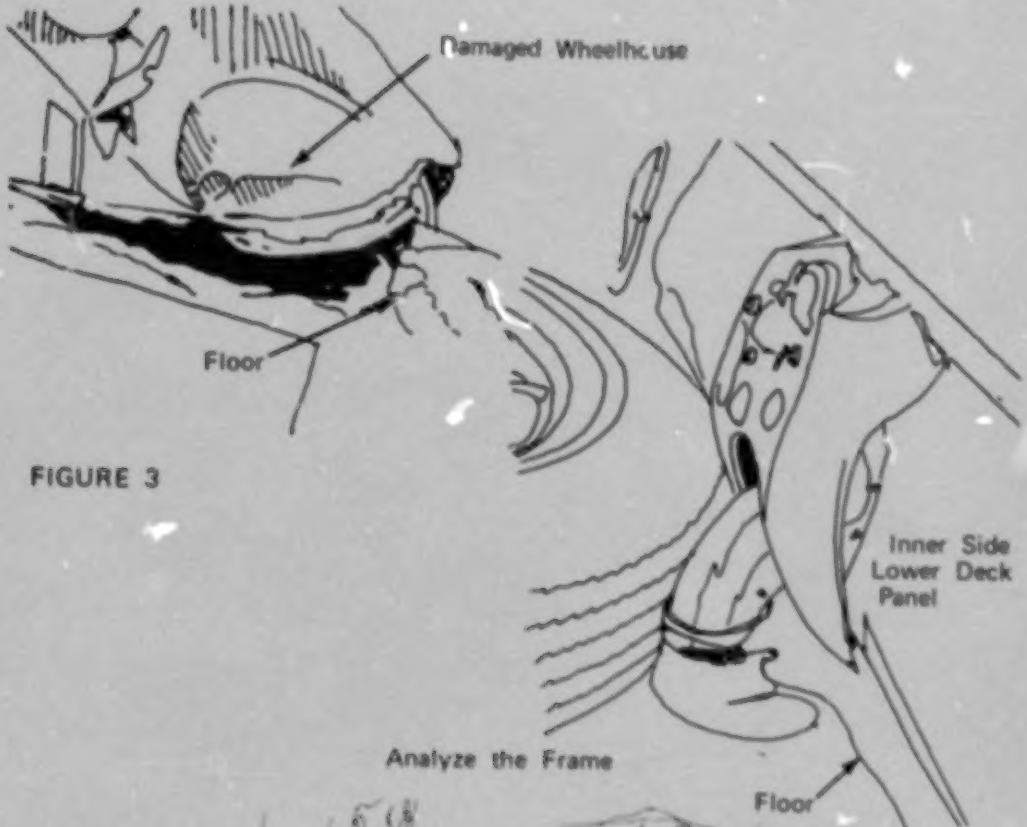

Damaged Wheelhouse
Floor
Inner Side Lower Deck Panel
Floor

FIGURE 3

Analyze the Frame

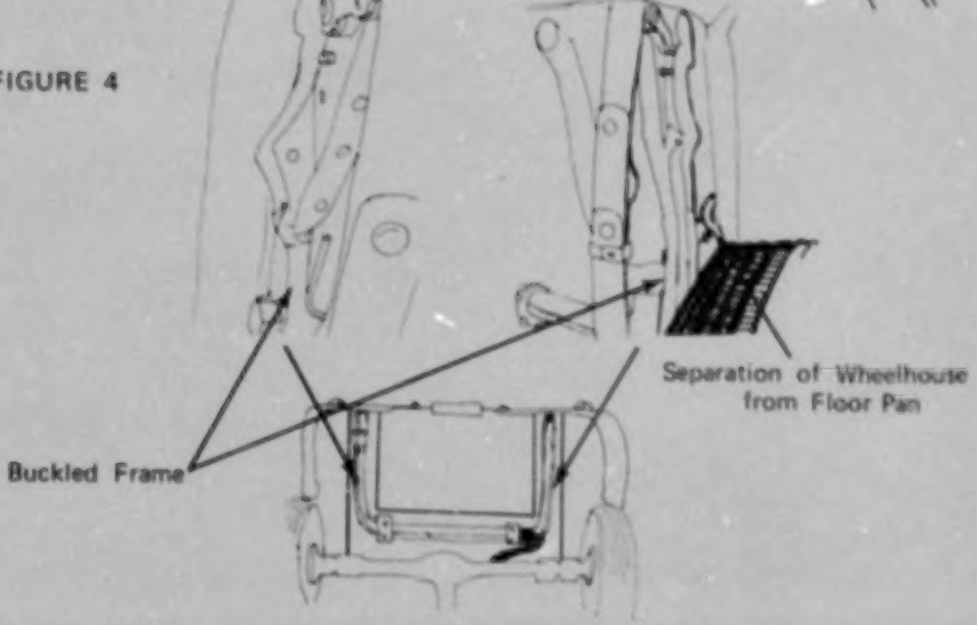

Separation of Wheelhouse from Floor Pan
Buckled Frame

FIGURE 4

JOB SHEET #9

B. Remove items from trunk storage area
    1. Spare tire
    2. Mat
    3. Other items

C. Remove good moldings and trim
    1. Lower deck pan
    2. Deck lid
    3. Quarter panels

D. Place vehicle on safety stands

(CAUTION: Place safety stands under correct areas on frame or suspension members.)

E. Hook up pull equipment and make pulls
    1. Straighten frame
        a. Correct mash
        b. Correct sway

(NOTE: During the pulling of the frame buckles in the sheet metal above the wheel openings, top, upper deck panel, etc. should normalize due to release of tension. Use a hammer and spoon, to spring hammer these areas down.)

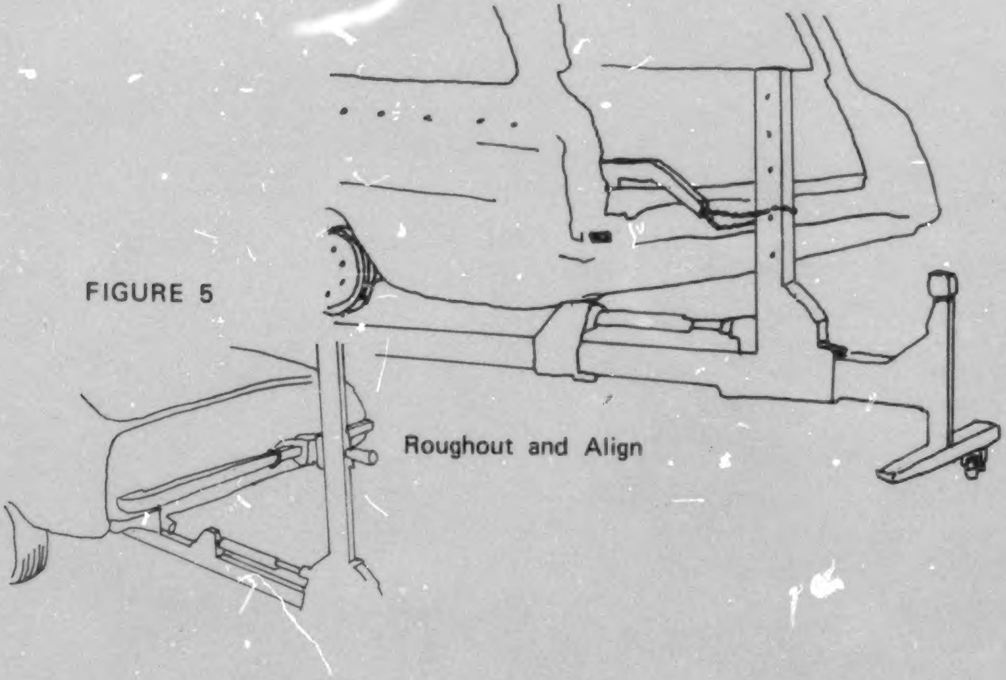
    2. Weld breaks and tears in floor that are a result of pulling

(NOTE: The floor area should normalize allowing points at the wheel housing to be roughout and welded.)

    3. Check the frame and repeat the above until frame is straight

4. Pull quarter panels and rear deck panel (Figure 5)

FIGURE 5



Roughout and Align

  a. Pull each quarter panel

    1. Relieve strain in panel sheet metal

    2. Weld tears and breaks as they occur

  b. Pull rear deck panel

  (NOTE: If a multiple hook up unit is available, it is always better to pull all points at the same time. If one unit is used, pull each point a little at a time relieving strain and tension across the total damaged body section.)

F. Straighten floor pan

  1. Weld all joints

  2. Straighten wheel houses

  3. Rear deck panels (upper or lower)

  4. Damaged floor pan sections

  5. Damaged frame cross members

(IMPORTANT: Always check with your instructor before making a pull.)

BUMPER AND PANEL ALIGNMENT
UNIT III

TEST

1. Match terms to definitions.

_____a. Rigid, reinforced steel or box to which engine, power train, and running gear are attached

_____b. The alignment of damaged panels, inner panals, and parts prior to their replacement insuring that the new parts will properly fit

_____c. The equipment when it is in place ready to use

_____d. Hooking the body and frame unit to the automobile by use of chains, clamps, or other attachments

_____e. Any device used to provide a "hookup" point on the body or frame

1. Hookup
2. Body clamp
3. Setup
4. Roughout
5. Unitized body

2. Tell when torn areas should be welded.

3. Tell when heat is necessary when aligning body panels.

4. Describe how buckles should be removed.

5. List five body parts that may need to be removed to get at the damage or pull points.

a.

b.

c.

d.

e.

6. Describe the amount of pressure necessary to release stress in metal.

7. List five basic steps to follow when doing repair work.

a.

b.

c.

d.

e.

8. Demonstrate the ability to:

a. Align a bumper with ends pushed into the body.

b. Align a bumper hit in the center.

c. Align a bumper with ends pulled out.

d. Align a damaged fender.

e. Align a damaged cowl.

f. Align a damaged door panel with vacuum equipment.

g. Align side damage.

h. Align top damage.

i. Align a rear section damage.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

BUMPER AND PANEL ALIGNMENT
UNIT III

ANSWERS TO TEST

1. a. 5

   b. 4

   c. 3

   d. 1

   e. 2

2. Before any pulling or pushing is done

3. Necessary only to keep from causing further damage and to help remove the crumpled areas

4. By heat or by hammering while tension is being applied

5. a. Hood

   b. Grill

   c. Bumpers

   d. Doors

   e. Deck lid

6. Pressure must be exerted to over correct the frame or body to allow for spring back when pressure is released

7. a. Locate the damage

   b. Plan the work

   c. Roughout the work

   d. Check the work

   e. Straighten or replace panels

8. Performance skills will be evaluated according to the criteria listed on the progress chart.

BODY PANEL REPLACEMENT
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with body panel replacement, identify the various types of panel joints and explain methods for panel removal and installation. He should be able to remove and replace all body panels on a vehicle. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with body panel replacement to definitions.
2. Identify seven types of body panel joints from an illustration of body joints.
3. List six methods of panel removal.
4. Name the five options that can be taken to remove and replace a body panel.
5. Name the three types of panel replacement.
6. Demonstrate the ability to:
    a. Replace a front fender and grill.
    b. Remove and replace the front end assembly.
    c. Remove and replace a hood or deck lid.
    d. Remove and replace a door.
    e. Repanel a door.
    f. Replace a rocker panel.
    g. Remove and replace a new quarter panel and lower deck panel.
    h. Remove and replace a used quarter panel.
    i. Remove and replace a new top panel.
    j. Remove and replace a top (used).
    k. Remove and install a rear body clip.

BODY PANEL REPLACEMENT
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Types of Body Panel Joints

      2. TM 2--Options Used to Remove and Replace Body Panels

   D. Job sheets

      1. Job Sheet #1--Remove and Replace a Front Fender and Grill

      2. Job Sheet #2--Remove and Replace the Front End Assembly

3. Job Sheet #3--Remove and Replace a Hood or Deck Lid
4. Job Sheet #4--Remove and Replace a Door
5. Job Sheet #5--Repanel a Door
6. Job Sheet #6--Replace a Rocker Panel
7. Job Sheet #7--Remove and Replace a New Quarter Panel and Lower Deck Panel
8. Job Sheet #8--Remove and Replace a Used Quarter Panel
9. Job Sheet #9--Remove and Replace a New Top Panel
10. Job Sheet #10--Remove and Replace a Top (Used)
11. Job Sheet #11--Remove and Install a Rear Body Clip

E. Test

F. Answer to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Company of Canada Limited, 1969.

B. McPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Book Company Inc., 1971.

C. Richert, Melvin T. *How to Control Auto Body Sheet Metals.* First Edition. Philadelphia, Pennsylvania: Chilton Book Company, 1968.

D. Sargent, Robert L. *Automobile Sheet Metal Repair.* Second Edition. Philadelphia, Pennsylvania: Chilton Book Company, 1969.

E. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

F. Toboldt, Bill. *Autobody Repairing and Repainting.* Third Edition. South Holland, Illinois: The Goodheart-Wilcox Company, Inc., 1972.

G. Wohlfiel, Theo A. *Automobile Body Reconditioning.* New York: McGraw-Hill Book Company, Inc., 1952.

H. *1972 Fisher Body Service Manual.* Fisher Body Division Part No. 8705501. General Motors Corporation, August 1971.

I. *General Motors General Service Information 1971/1972 Assembly Illustrations.* General Motors Corporation, April 1972.

J. *Ford Automobile Body and Collision Parts Catalog.* AF-7832-72, 1972 Edition.

BODY PANEL REPLACEMENT
UNIT IV

INFORMATION SHEET

I. Terms and definitions

   A. Short cut--To replace only the damaged portion of a body panel (sectioning)

   B. Sectioning--When damage to a large panel requires only part of the panel to be replaced, the new panel is cut to fit the required damaged area to be replaced and welded in

   C. Body clip--Replacing part of the body as a unit; this replacement part is purchased used intact (such as quarter panels, deck lid, floor, top, glass)

   D. R and R--Remove and replace

   E. R and I--Remove and reinstall

   F. Repanel--Replacing the outer panel (skin) of a door using the original inner door panel

   G. Flanging--Crimping the panel on a door with a hammer and dolly block or crimping tool

II. Types of body panel joints (Transparency 1)

   A. Lap joint spot welded

   B. Lap joint gas welded

   C. Hemming flange

   D. Gutter spot weld

   E. Lap joint, welded and filled

   F. Pinch-weld flange, welded

   G. Couch joint, welded and filled

III. Methods of panel removal

   A. Panel cutter

   B. Cutting torch

   C. Arc welder

   D. Drilling each spot weld

INFORMATION SHEET

E. Hacksaw

F. Breaking welds with a hammer and chisel

IV. Options for removing and replacing a panel (Transparency 2)

A. Replace entire panel

B. Cut at belt line

C. Cut at peak of panel

D. Cut along beads

E. Use small sections

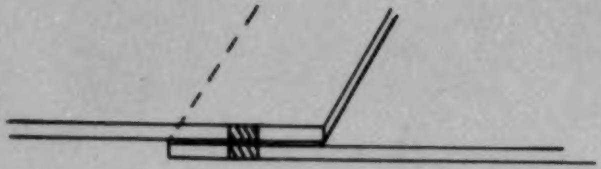
V. Types of panel replacement

A. Complete panel replacement

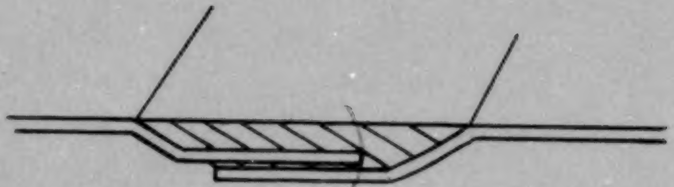
B. Replacement of most of the panel sectioning in small areas

C. Partial panel replacement--Using half and installing only one section

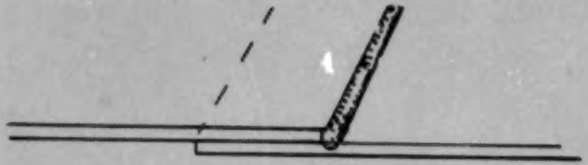
Types of Body Panel Joints



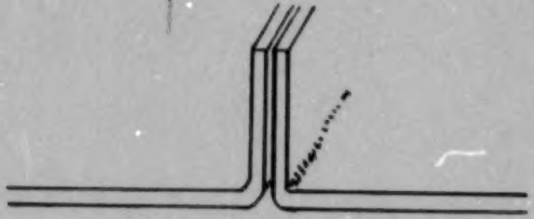
Lap Joint, Spot Welded



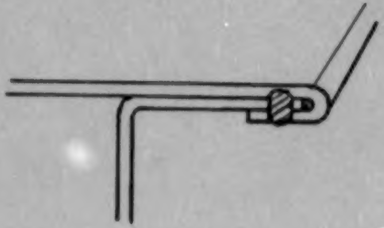
Lap Joint, Welded, and Filled



Lap Joint, Gas Welded

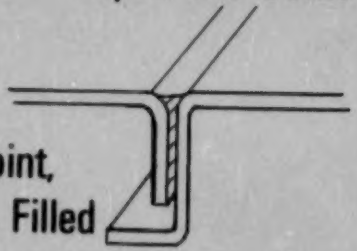


Pinch-Weld Flange, Welded

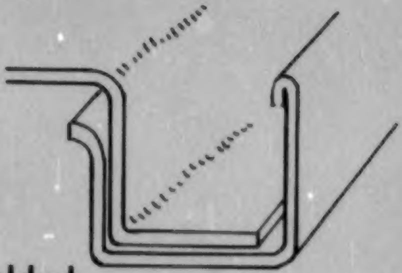


Hemming Flange

Solder or Plastic Wiped into Joint

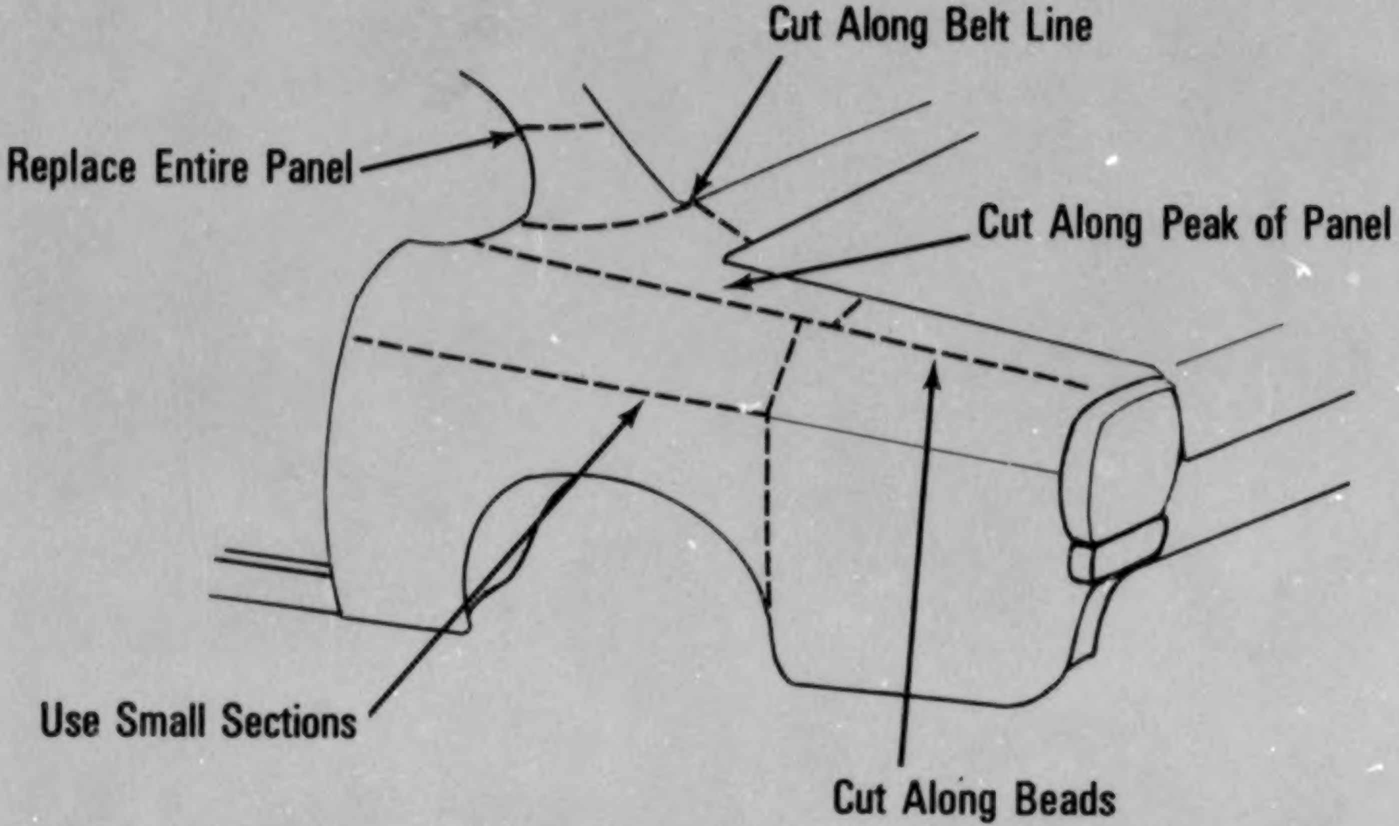


Couch Joint, Welded , Filled



Gutter, Spot Welded

Options Used to Remove and Replace Body Panels


Cut Along Belt Line
Replace Entire Panel
Cut Along Peak of Panel
Use Small Sections
Cut Along Beads

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #1--REMOVE AND REPLACE FRONT FENDER AND GRILL

I. Tools and equipment

- A. Mechanic's hand tool set
- B. Body hammers
- C. Dolly blocks
- D. Oxyacetylene torch unit
- E. Lift jack and safety stands
- F. Hydraulic body jack set

II. Procedure

- A. Raise hood and analyze the bolting sequence of parts to be removed
- B. Remove tire from fender side to be removed and place on safety stand

  (CAUTION: Set safety stand in a designated area to prevent injury from vehicle falling from stand.)
- C. Remove front bumper assembly
  - 1. Remove bumper bracket bolts from ends of bumper to fender
  - 2. Remove bolts from frame
  - 3. Remove bumper with brackets attached
- D. Remove front fender extension and door

  (NOTE: Depending on how the grill is bolted on, determine whether this step is necessary.)
- E. Remove grill
  - 1. Remove bolts
    - a. Lock support to grill
    - b. Stone deflector to grill
    - c. Radiator support or tie bar to grill

JOB SHEET #1

        d. Fender to grill

        e. Disconnect parklamps if applicable

    2. Remove grill

F. Remove headlight assembly if applicable

    1. Disconnect wires

    2. Remove attaching bolts or screws and remove entire unit

G. Remove inner fender skirt

    1. Remove bolts along wheel opening

    2. Remove bolts at front along radiator supports

    3. Remove bolts from braces

    4. Remove skirt from vehicle

H. Remove fender

    1. Remove bolts from headlight door or fender extension opening to braces and radiator support

    2. Remove bolts from fender to top of radiator support

    3. Remove bolts from hinge

    (NOTE: Brace hood and hinge to prevent the hood from falling or slipping into the windshield.)

    4. Remove bolts from lower cowl

    5. Remove bolts from upper cowl

    6. Remove fender from vehicle

I. Remove moldings and trim from fender and install on new fender

J. Repair any damage to cowl or supports as necessary

K. Install fender on vehicle

    1. Align fender with cowl and door

    (NOTE: Be sure and align the fender properly to allow opening and closing of the door. Correct door to fender gap 3/16 inch.)

JOB SHEET #1

2. Bolt fender to radiator support
3. Bolt hood hinge to fender
    a. Close hood and check alignment
    b. Align fender at radiator support and upper cowl to hood
    c. Align back of hood at hood hinge to fender and cowl

L. Install inner fender skirt

M. Install headlight assembly
    1. Connect wires
    2. Aim headlight assembly

N. Install grill

O. Install headlight door or fender extension

P. Install and align front bumper

Q. Install tire

R. Have instructor check work

S. Remove safety stand and send to paint shop

(NOTE: This is a general plan for R and R a grill and fender. Because of the many vehicles and type of vehicles produced today, analyze the attaching sequence and remove parts as necessary. Review shop service manuals before attempting to remove any parts.)

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #2--REMOVE AND REPLACE THE FRONT END ASSEMBLY

I. Tools and equipment

- A. Mechanic's hand tool set
- B. Body hammers
- C. Dolly blocks
- D. Oxyacetylene torch set
- E. Lift jack and safety stands
- F. Hydraulic body jack set

II. Procedure

- A. Place vehicle on safety stands and remove wheels
- B. Align damaged sheet metal using frame and body straightening unit
- C. Remove hood
- D. Remove accessories
  1. Remove battery
  2. Remove radiator hoses

     (NOTE: Drain radiator before removing hoses.)
  3. Remove wiring harness
  4. Bleed air-conditioning system

     (CAUTION: For contents under pressure, bleed systems in a well ventilated area. Be careful to avoid contact with freon on skin. Breathing this vapor may be fatal.)
  5. Disconnect air-conditioning hoses from evaporator
  6. Remove other accessory units as necessary
- E. Remove front bumper assembly
- F. Remove radiator support bolts to frame

JOB SHEET #2

G. Remove bolts from inner fender skirt to frame, supports, and cowl

H. Remove bolts from fender to lower cowl

I. Remove bolts from upper cowl

J. Remove front end assembly

(NOTE: Lift front end assembly with the help of at least two people over wheel hubs and off the front of the frame.)

K. Align and straighten frame if necessary

L. Align and straighten cowl if necessary

M. Install parts from damaged front end on new front end assembly

(NOTE: When purchasing a front end assembly, many times moldings and trim will differ requiring the changing of these items.)

N. Replace any mechanical parts as necessary

1. Water pump
2. Fan and/or assembly
3. Motor mounts
4. Damaged belt and pullies

O. Install new front end assembly

1. Check front radiator support gromment and install
2. Align fender to cowl and doors
3. Install bolts

   (NOTE: Do not tighten bolts until all are started. This will allow for the aligning of all holes in adjusting of the front end to fit the cowl and doors properly.)

4. Align front end assembly and tighten all bolts
5. Install or hook up all hoses, lines, wiring etc.

   (NOTE: Check the operation of each to insure that everything works including lifhts and the horn. Fill radiator with the proper amount of water and check for leaks.)

JOB SHEET #2

6. Install hood and align

7. Recheck lights, horn, and install antifreeze

8. Service air-conditioner

9. Have instructor check front end assembly

P. Install wheels, remove safety stand, and send to paint shop

Q. Align steering system

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #3--REMOVE AND REPLACE A HOOD OR DECK LID

I. Tools and equipment

  A. Mechanic's hand tool set

  B. Body hammer

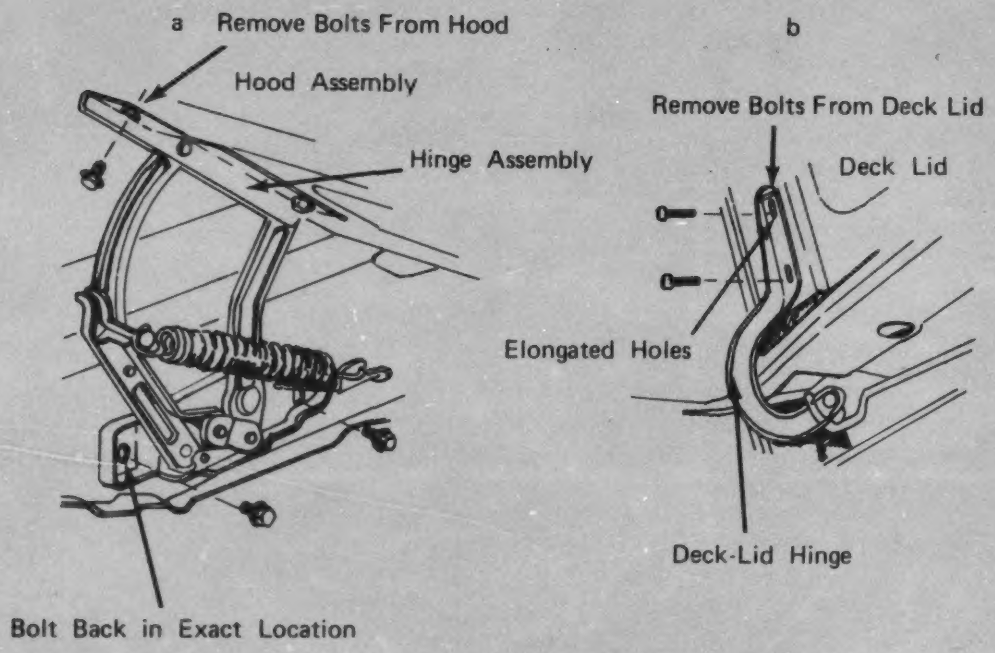
  C. Alignment punch set

II. Procedure

  A. Remove all moldings and trim

  B. Remove bolts or nuts from hinge to hood or deck lid location (Figure 1)

FIGURE 1


a
Remove Bolts From Hood
Hood Assembly
Hinge Assembly
Bolt Back in Exact Location
b
Remove Bolts From Deck Lid
Deck Lid
Elongated Holes
Deck-Lid Hinge

(NOTE: Have a helper hold or block the hood or deck lid up during this operation to prevent the panel from falling down or slipping back in to the windshield or back glass.)

JOB SHEET #3

C. Remove panel and discard

D. Check hinges

   1. Replace if damaged

   2. Bolt on in exact location of the old hinge

      (NOTE: By bolting on in the exact position of the old hinge, adjustment in this area can usually be eliminated.) (See Figure 1.)

E. Bolt hood or deck lid on hinges

   1. Snug up bolts

   2. Lower hood or deck lid slowly

      (NOTE: Have a helper watch back of hood or front of deck lid to be sure it does not scrape cowl or upper deck panel.)

   3. Adjust to fit opening

   4. Raise panel slowly and tighten bolts

F. Install moldings and trim

   1. Drill holes if necessary

   2. If trim is installed with an adhesive, do not install until painting is complete

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #4--REMOVE AND REPLACE A DOOR

I. Tools and equipment

  A. Mechanic's hand tool set

  B. Door handle remover tools

  C. Alignment punch set

II. Procedure

  A. Remove trim panel

  B. Remove bolts from hinges

  C. Remove door from vehicle

  (NOTE: Have painter refinish new door jam and trim and moldings areas so parts can be installed.)

  D. Exchange parts as necessary from damaged door to new door

    1. Glass

    2. Regulator

    (CAUTION: Regulator is spring loaded. Damage to this system could result in regulator springing open and causing danger to arms, hands, and fingers by amputating them.)

    3. Door locks

    4. Outside handle

    5. Moldings and trim

    6. Lock remote control

    7. Weather strip and other parts

  E. install new door on vehicle and align

  F. Install trim panel

  G. Send to paint shop

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #5--REPANEL A DOOR

I. Tools and equipment

   A. Mechanic's hand tool set

   B. Door handle remover tools

   C. Body grinder

   D. Finish hammer

   E. Dolly block

   F. Special door edge crimping tool

   G. Welding unit (oxyacetylene or electric)

   H. Drill 1/4 inch

   I. Drill bit set

   J. Alignment punch set

II. Procedure

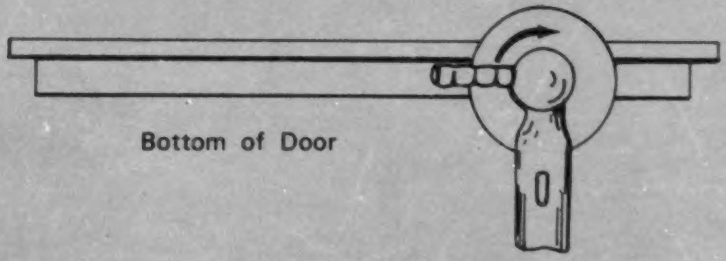
   A. Remove interior and exterior trim

   B. Remove door from hinges

   (NOTE: Some body men do not remove the door.)

   C. Grind the edge of the door cutting the outer panel loose (Figure 1)

FIGURE 1



(CAUTION: Wear goggles and disc away from other persons. This type of discing is very dangerous. Be sure you use the right techniques to prevent injury to yourself and others.)

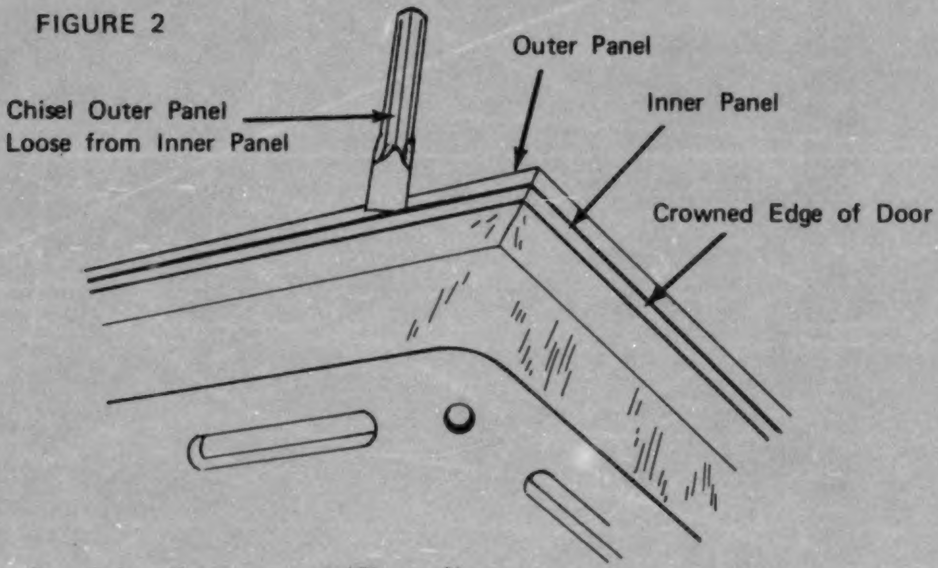
JOB SHEET #5

D. Chisel outer panel loose from inner panel

1. Grind all areas smooth

2. Align edges using hammer and dolly (Figure 2)

FIGURE 2


Outer Panel
Chisel Outer Panel Loose from Inner Panel
Inner Panel
Crowned Edge of Door

E. Reinstall inner panel (Figure 3)

FIGURE 3

JOB SHEET #5

1. Align inner panel

2. Straighten door facing

(NOTE: Inner panel must fit perfectly or door will not fit when panel is installed.)

F. Remove door inner panel

G. Install replacement panel

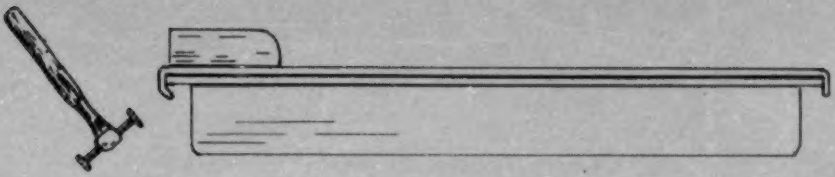
1. Fit outer panel over inner panel

(NOTE: Panel must fit perfectly.)

2. Flange outer panel over inner panel

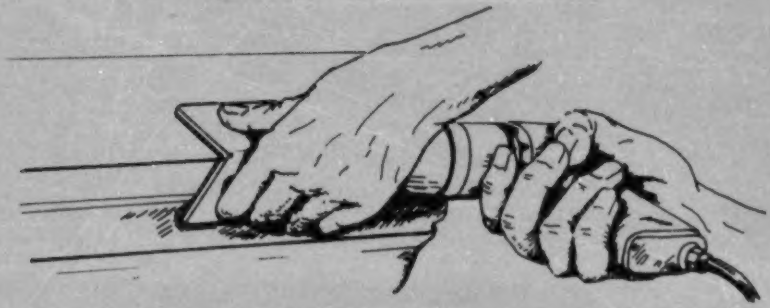
a. Hammer and dolly (Figure 4)

FIGURE 4



b. Pneumatic tool (Figure 5)

FIGURE 5



JOB SHEET #5

H. Rehang door
   1. Align door perfectly
   2. Spot weld edges and corners

I. Remove door
   1. Weld corners
   2. Braze areas between corners

   (NOTE: A mig welder with spot attachment will do an excellent job eliminating heat distortion.)

J. Seal joints with seam sealer
   1. Have painter prime and refinish areas
   2. Install any weatherstrip or parts that had to be removed

K. Install door on vehicle and align

L. Install exterior and interior moldings and trim

(NOTE: Repaneling a door can be accomplished with all hardware intact. Remember to protect glass when welding to prevent damage or breakage.)

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #6--REPLACE ROCKER PANEL

I. Tools and equipment

  A. Mechanic's hand tool set

  B. Body hammers

  C. Dolly blades

  D. Frame and body straightening unit

  E. Hydraulic jack set

  F. Welding unit (oxyacetylene and electric)

  G. Lift jack and safety stands

  H. Pry bars

  I. Alignment puncher

  J. Body fillers (solder or plastic)

  K. Seam sealers and undercoats

II. Procedure

  A. Remove parts that will interfere with repair operations

    1. Doors

    2. Step plates

    3. Seats

    4. Floor mats

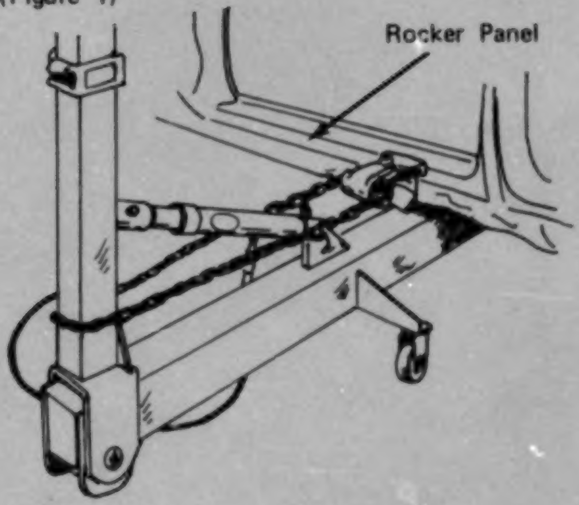
    5. Upholstery

    6. Other items

JOB SHEET #6

B. Pull out damage (Figure 1)

FIGURE 1



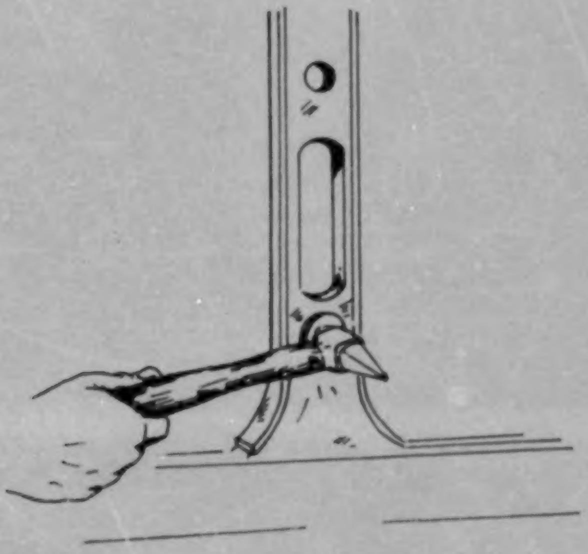
1. Roughout floor
2. Roughout inner rocker panel

C. Cut out damaged outer panel

(NOTE: Use pneumatic chisel. Do not use a cutting torch unless there is no other way. Fire danger is very high in this operation.)

D. Straighten inner reinforcing panels (Figure 2)

FIGURE 2



JOB SHEET #6

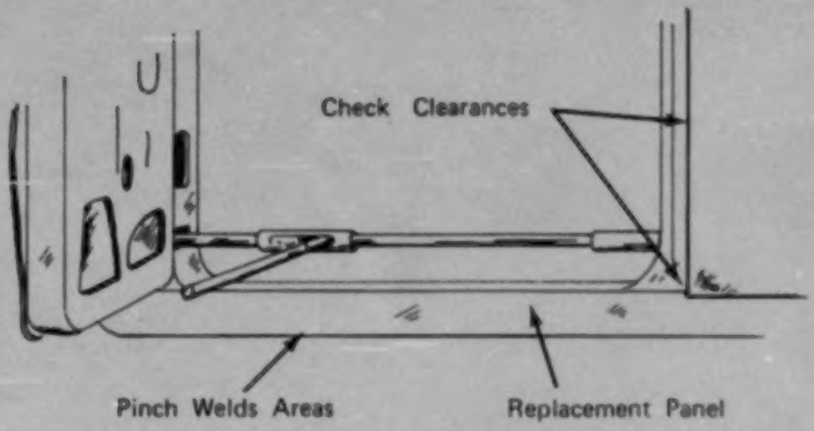
E. Strip outer panel metal from pinch weld and other spot weld areas

1. Grind smooth
2. Align edge with hammer and dolly block

F. Fit new panel

1. Place panel in opening and clamp with vise grip pliers
2. Check alignment of inner panels and pinch weld areas
3. Check alignment with doors in openings to insure proper clearance (Figure 3)

FIGURE 3



G. Spot weld and finish the panel

1. Method one--Oxyacetylene

   (NOTE: Due to excessive heat with this method, do not try to weld this panel in one operation. Take plenty of time and allow welds to cool before welding another bead or plug. If this is not done, distortions will occur and the panel will not fit tolerances due to shrinkage.)

   a. Spot all corners and several areas around area
   b. Spot every inch along spot welds and pinch weld with a plug weld or bead one inch long
   c. Weld ends of panel shut from pinch weld to inner panel on the top

JOB SHEET #6

d. Grind, clean, and fill areas

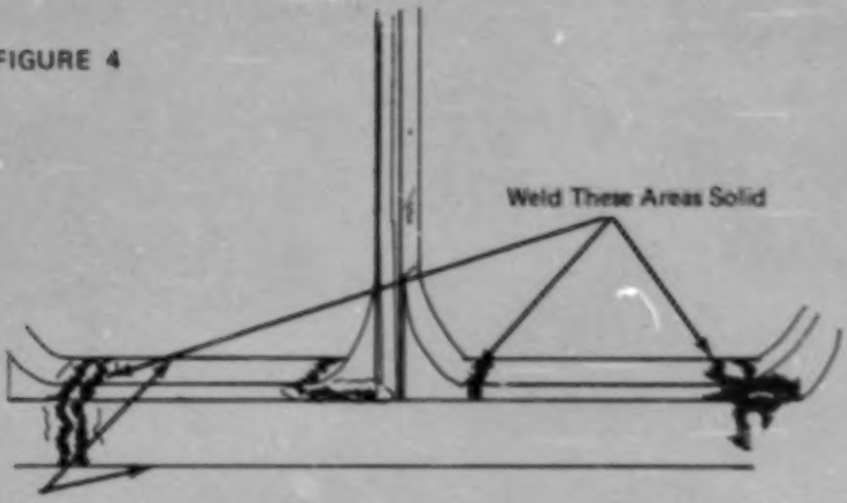
(NOTE: Use solder or body plastic filler.)

e. Finish the metal for the painter

2. Method two--Mig weld (Figure 4)

(NOTE: Because of low heat, the panel can be welded in a continuous operation.)

FIGURE 4



a. Spot all corners and several areas around the panel (use spot setting)

b. Spot around entire panel every one-half inch (use spot setting)

c. Weld panel ends shut

d. Grind, clean, and fill areas

(NOTE: Use solder or body plastic filler.)

e. Finish the metal for the painter

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #7--REMOVE AND REPLACE A NEW QUARTER PANEL AND LOWER DECK PANEL

I. Tools and equipment

A. Mechanic's hand tool set

B. Body hammers

C. Dolly blades

D. Frame and body straightening unit

E. Hydraulic jack set

F. Welding unit (oxyacetylene and electric)

G. Lift jack and safety stands

H. Pry bars

I. Alignment puncher

J. Body fillers (solder or plastic)

K. Seam sealers and undercoats

II. Procedure

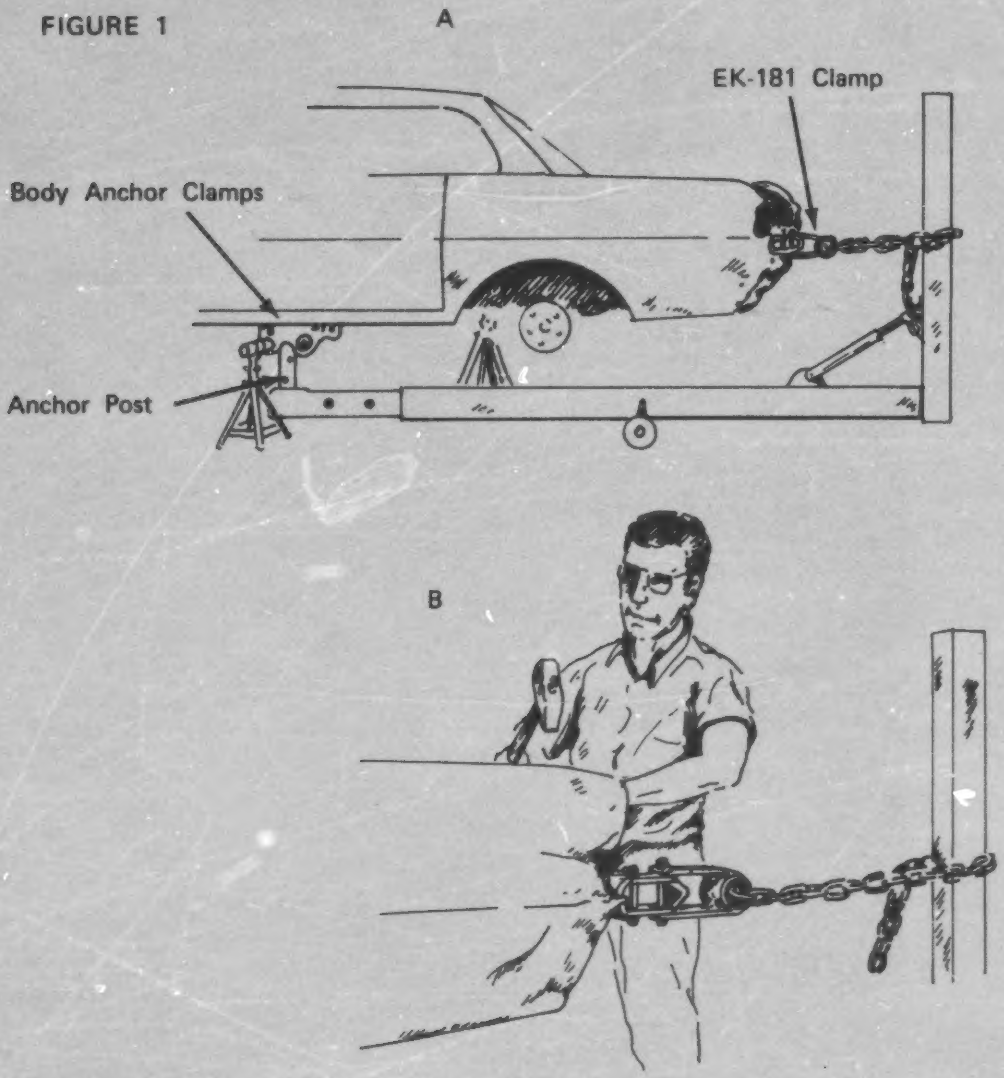
A. Remove all parts that will interfere with the panel replacement

B. Straighten frame

JOB SHEET #7

C. Align body panel (Figure 1)

FIGURE 1


A
EK-181 Clamp
Body Anchor Clamps
Anchor Post
B

(NOTE: Whenever possible, use the damaged sheet metal to help pull the connecting members (such as braces or brackets) back into place. Repair or replace wheel house panel as necessary.)

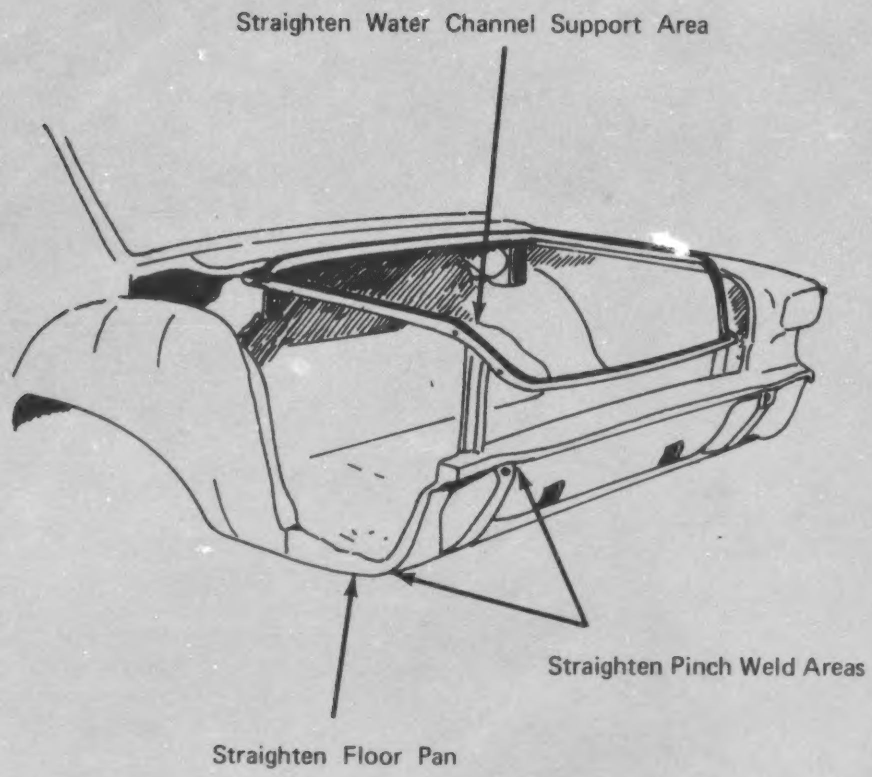
D. Cut damaged panel off

(NOTE: Several options may be used when replacing panels.)

JOB SHEET #7

E. Straighten interior braces, floor pan, brackets (Figure 2)

FIGURE 2


Straighten Water Channel Support Area
Straighten Pinch Weld Areas
Straighten Floor Pan

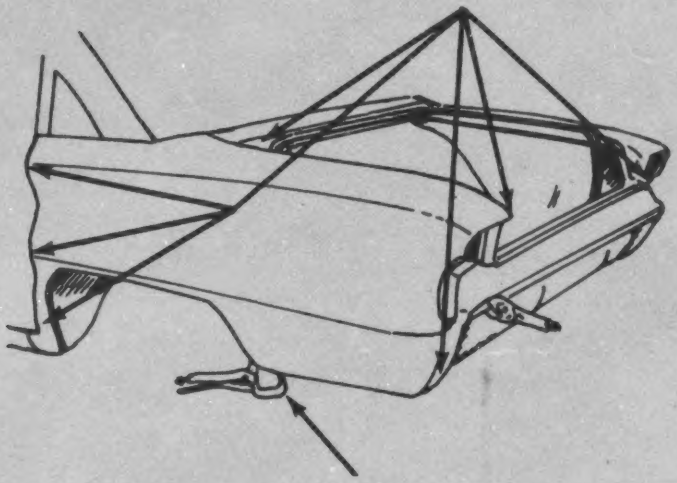
F. Grind off all spot weld areas

(NOTE: This is necessary to insure proper fit of the new panel and to allow for metal contact between the inner panel and replacement panel during spot welding.)

JOB SHEET #7

G. Position new panels on automobile and clamp with vise grip pliers (Figure 3)

FIGURE 3



H. Spot weld panels to body and check alignment with door, deck lid, and rear glass (See Figure 3.)

I. Weld panel in (oxyacetylene or mig)

(NOTE: Due to excessive heat with this method, do not try to weld this panel in one operation. Take plenty of time and allow welds to cool before welding another bead or plug. If this is not done, distortion will occur and panel will not fit tolerances due to shrinkage.)

1. Spot weld along
    - a. Trunk opening
    - b. Door jam
    - c. Wheel house
    - d. Floor pan
    - e. Rear deck panel
    - f. Gas filler door

JOB SHEET #7

2. Weld solid
    a. Joint between top and quarter panel
    b. All short cut joints

J. Check door and trunk alignment and correct if necessary

K. Finish work on weld areas
  1. Fill joints (Solder or plastic body filler)
    a. Between outer body panels
    b. In short cut areas

    (NOTE: When welding panels, slag forms which must be removed before filling. Failure to do so will result in filler cracking out. Poor workmanship is the result plus unhappy customers.)

L. Install all parts to check for fit
  1. Align parts to vehicle
  2. Straighten panel to fit parts if necessary

M. Seal all body joints with seam sealer and undercoat as required

(NOTE: Vehicle should be ready for painter.)

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #8--REMOVE AND REPLACE A USED QUARTER PANEL

I. Tools and equipment

A. Mechanic's hand tool set

B. Body hammers

C. Dolly blades

D. Frame and body straightening unit

E. Hydraulic jack set

F. Welding unit (oxyacetylene and electric)

G. Lift jack and safety stands

H. Pry bars

I. Alignment puncher

J. Body fillers (solder or plastic)

K. Seam sealers and undercoats

II. Procedure

A. Remove moldings, trim, glass, bumper, and other parts that will interfere with replacement of the panel

B. Straighten frame

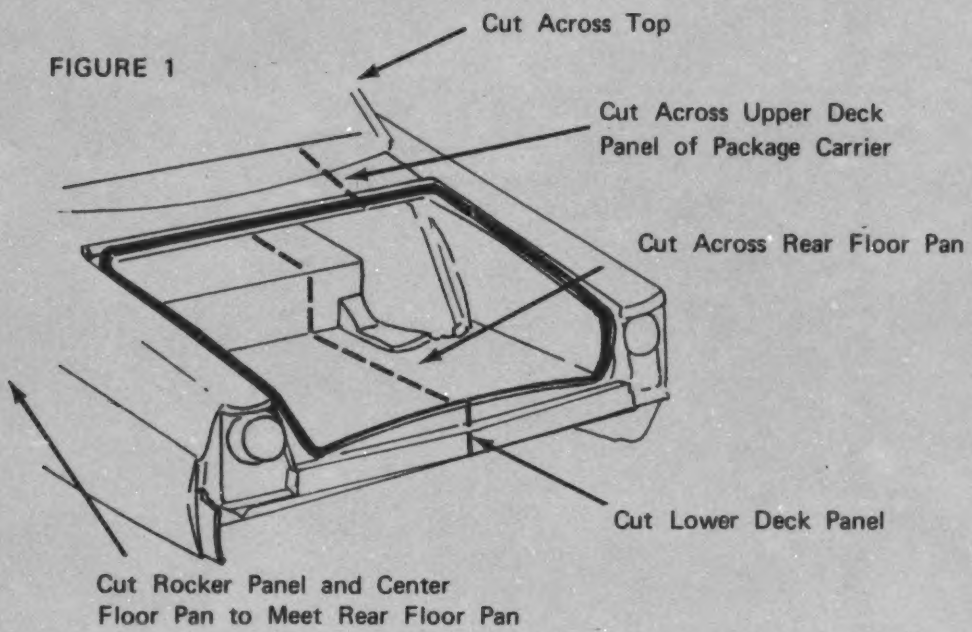
C. Align damaged body panel

(NOTE: Whenever possible, use the damaged sheet metal to help pull the connecting members (such as braces or brackets) back into place. Repair or replace wheelhouse as necessary.)

JOB SHEET #8

D. Determine how to cut damaged panel out (Figure 1)

FIGURE 1


Cut Across Top
Cut Across Upper Deck Panel of Package Carrier
Cut Across Rear Floor Pan
Cut Lower Deck Panel
Cut Rocker Panel and Center Floor Pan to Meet Rear Floor Pan

(NOTE: There are many ways to cut in a used quarter panel. Use the method that is the most economical and will make the best repair. Check with your instructor before cutting off damaged panel.)

E. Cut replacement panel to match damaged panel

(NOTE: When purchasing a used panel, tell the salvage operator where you want the panel cut. Always allow six to eight inches for trimming.)

F. Align replacement panel in opening

1. Attach vise grip pliers
2. Tack weld where necessary
3. Check clearances
    a. Deck lid
    b. Door
    c. Bumper

JOB SHEET #8

G. Weld panel in

(CAUTION: Review all welding safety rules.)

1. Outer joints
2. Interior braces and joints
3. Floor pan

(NOTE: Check clearance during the welding operation to be sure shrinkage has not caused poor alignment of deck lid and doors.)

H. Finish panels

1. Fill all joints (solder or plastic body filler)
2. Undercoat exterior and interior sides of welds

I. Install parts to insure proper fit and alignment

(NOTE: Have the painter prime all areas. Other parts may be left on eliminating having to remove and install twice.)

BODY PANEL REPLACEMENT
UNIT III

JOB SHEET #9--REMOVE AND REPLACE A NEW TOP PANEL

I. Tools and equipment

- A. Mechanic's hand tool set
- B. Body hammers
- C. Dolly blades
- D. Frame and body straightening unit
- E. Hydraulic jack set
- F. Welding unit (oxyacetylene and electric)
- G. Lift jack and safety stands
- H. Pry bars
- I. Alignment puncher
- J. Body fillers (solder or plastic)
- K. Seam sealers and undercoats

II. Procedure

- A. Remove all moldings, trim, and glass
    - 1. Interior
    - 2. Exterior
- B. Align
    - 1. Roof rails
    - 2. Posts
    - 3. Windshield and backwindow headers

      (IMPORTANT: All doors and glass must fit before top is completely removed and replaced.)
- C. Cut top off

JOB SHEET #9

D. Trim remaining edges and smooth with grinder

(NOTE: If drip rail is damaged, replace at this time.)

E. Set top on headers

(NOTE: Top must fit. If it does not, realign headers and check all doors and window openings before installing top.)

F. Spot weld top to drip rail and headers

(NOTE: If mig welder is available, this is the best method of spotting top on. If mig welder is not available, weld or braze as necessary. Let each spot cool completely to prevent distortion of the top.)

G. Straighten any distortion that might have occurred

H. Seal drip molding

I. Install all parts removed to insure alignment and fit

(NOTE: Be sure all parts fit before refinishing is accomplished.)

BODY PANEL REPLACEMENT
UNIT III

JOB SHEET #10--REMOVE AND REPLACE A TOP (USED)

I. Tools and equipment

- A. Mechanic's hand tool set
- B. Body hammers
- C. Dolly blades
- D. Frame and body straightening unit
- E. Hydraulic jack set
- F. Welding unit (oxyacetylene and electric)
- G. Lift jack and safety stands
- H. Pry bars
- I. Alignment puncher
- J. Body fillers (solder or plastic)
- K. Seam sealers and undercoats

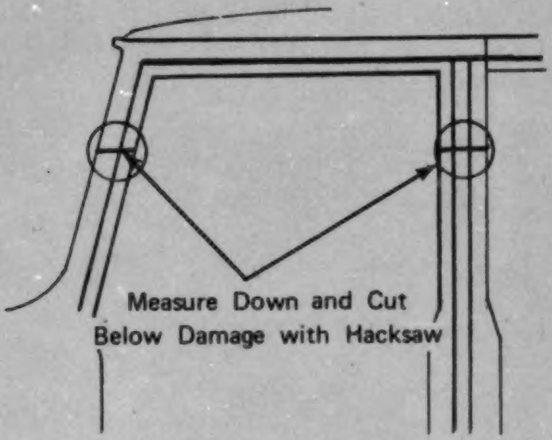
II. Procedure

- A. Remove all moldings, trim, and glass
  - 1. Interior
  - 2. Exterior
- B. Align posts

JOB SHEET #10

C. Measure down from top on post below any damage and cut post with hacksaw (Figure 1)

FIGURE 1


Measure Down and Cut
Below Damage with Hacksaw

D. Cut replacement top at the same point

E. Set replacement top on posts

   1. Align posts

   2. Tack weld

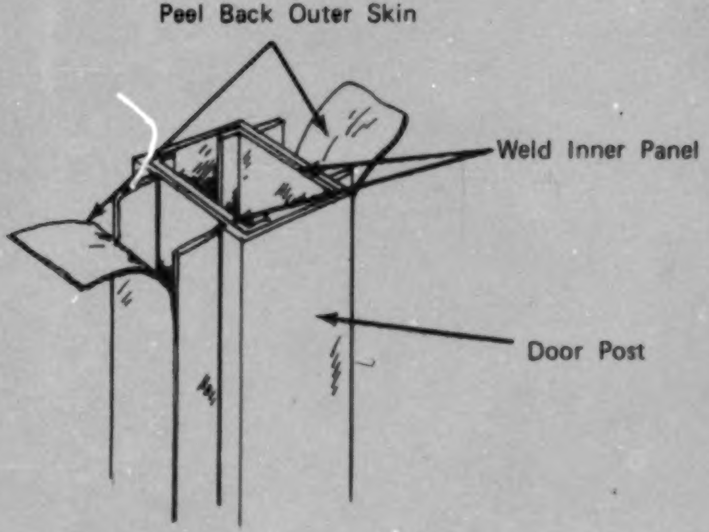
F. Fit doors and glass

(NOTE: Doors and glass must fit. If they do not, correct the problem before continuing with installation.)

JOB SHEET #10

G. Weld posts together (Figure 2)

FIGURE 2



(NOTE: Because of the construction of the post, it is necessary to peel back part of the outer skin to allow the inner post to be welded.)

1. Weld interior post
2. Weld exterior post

H. Metal finish post

I. Install molding, trim, and glass

(NOTE: Have the painter prime and refinish the metal worked areas so that moldings trim and glass may remain after installation.)

(NOTE: If any sealing or undercoating is necessary, be sure to do this before parts and glass are installed.)

BODY PANEL REPLACEMENT
UNIT IV

JOB SHEET #11–REMOVE AND INSTALL REAR BODY CLIP

I. Tools and equipment

   A. Mechanic's hand tool set

   B. Body hammers

   C. Dolly blades

   D. Frame and body straightening unit

   E. Hydraulic jack set

   F. Welding unit (oxyacetylene and electric)

   G. Lift jack and safety stands

   H. Pry bars

   I. Alignment puncher

   J. Body fillers (solder or plastic)

   K. Seam sealers and undercoats

II. Procedure

   A. Set vehicle on safety stands and remove rear wheels

   B. Align body and frame with body and frame straightening unit

   C. Remove necessary parts

      1. Exterior moldings and trim

      2. Rear bumper

      3. Deck lid

      4. Interior moldings and trim

      5. Drop rear of headliner

      6. Remove back glass

      7. Remove all upholstering as necessary

      8. Remove gas tank

      9. Remove vinyl top if required

JOB SHEET #11

D. Brace top as necessary

(NOTE: Bracing depends on the method with which the clip is installed.)

E. Cut body along the chosen route

   1. Mark area to be cut by using precise measurements from body construction points

   2. Use a power saw and/or panel cutter to leave a smooth cutting edge

F. Remove body bolts

G. Remove damaged rear clip assembly

H. Trim replacement clip to match damaged assembly

I. Replace frame section if necessary

   1. Cut damaged frame out at specifically measured points

   2. Carefully cut and align replacement section and spot weld to remaining frame

   3. Gauge frame

   4. Weld in replacement section (fishplate if necessary)

   5. Gauge frame

   (NOTE: When stubbing in a frame, take plenty of time and carefully install. Have your instructor assist during every step.)

J. Install replacement clip

   1. Set clip on frame and start body bolts

   (NOTE: Do not tighten bolts so the clip can be shifted as necessary to align with top and floor.)

   2. Spot weld top and floor

   3. Check alignment of back glass

   4. Check alignment of doors

   5. Weld top together

      a. Oxyacetylene--Use heat shields to prevent distortion of metal and weld only a short distance allowing for forging of welds and cooling of metal

JOB SHEET #11

        b. Electric (Mig)--Weld top

        (NOTE: Protect all glass and interior trim from sparks.)

        (CAUTION: Protect all vehicle body parts and trim from fire. Wear appropriate goggles and safety clothes. Check area around vehicle and remove any inflammables.)

        c. Check rear glass opening

        (NOTE: Use glass or tone measure as necessary.)

    6. Weld rocker panel together

    (NOTE: Check door alignment for fit.)

    7. Weld floor together

    8. Tighten body bolts

    (NOTE: Recheck all glass and doors for proper alignment.)

K. Straighten and fill all welds as necessary

L. Have paint shop do preliminary work

    1. Prime all metal worked areas

    2. Refinish door jams

M. Install all parts as required

N. Have instructor check repair and installation

O. Send vehicle to paint shop

(NOTE: Body clips must be carefully installed. If installed correctly, it will make a fast and excellent repair. Always carefully analyze the entire operation before installing a clip.)

BODY PANEL REPLACEMENT
UNIT IV

TEST

1. Match terms to definitions.

_____a. Remove and replace

_____b. Replacing part of the body as a unit; the replacement part is purchased used intact (such as quarter panels, deck lid, floor, top, glass)

_____c. To replace only the damaged portion of a body panel (sectioning)

_____d. Remove and reinstall

_____e. Replacing the outer panel (skin) of a door using the original inner door panel

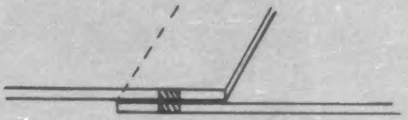
_____f. Crimping the replacement panel on a door with a hammer and dolly block or crimping tool

_____g. When damage to a large panel requires only part of the panel to be replaced, the new panel is cut to fit the required damaged areas to be replaced and welded in

1. Short cut
2. Sectioning
3. Body clip
4. R and R
5. R and I
6. Repanel
7. Flanging

2. Identify seven types of body panel joints.

a. ______________________



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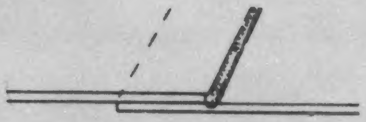
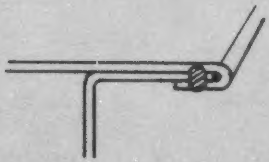
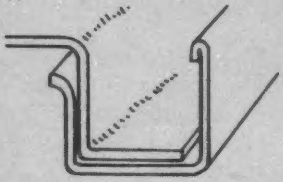
b. ______________________________



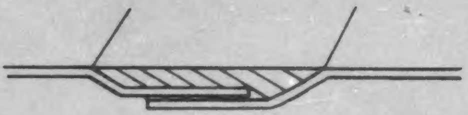
c. ______________________________



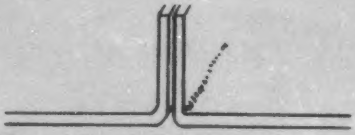
d. ______________________________



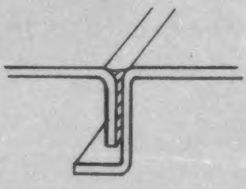
e. ______________________________



f. ______________________________



g. ______________________________



3. List six methods of panel removal.

a.

b.

c.

d.

e.

f.

4. Name five options that can be taken to remove and replace a body panel.

   a.

   b.

   c.

   d.

   e.

5. Name the three types of panel replacement.

   a.

   b.

   c.

6. Demonstrate the ability to:

   a. Replace a front fender and grill.

   b. Remove and replace front end assembly.

   c. Remove and replace hood or deck lid.

   d. Remove and replace a door.

   e. Repanel a door.

   f. Replace a rocker panel.

   g. Remove and replace a new quarter panel and lower deck panel.

   h. Remove and replace a used quarter panel.

   i. Remove and replace a new top panel.

   j. Remove and replace a top (Used).

   k. Remove and install a rear body clip.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

BODY PANEL REPLACEMENT
UNIT IV

ANSWERS TO TEST

1. a. 4
   b. 3
   c. 1
   d. 5
   e. 6
   f. 7
   g. 2
2. a. Lap joint spot welded
   b. Lap joint gas welded
   c. Hemming flange
   d. Gutter spot weld
   e. Lap joint, welded and filled
   f. Pinch-weld flange, welded
   g. Couch joint, welded and filled
3. a. Panel cutter
   b. Cutting torch
   c. Arc welder
   d. Drilling each spot weld
   e. Hacksaw
   f. Breaking welds with a hammer and chisel
4. a. Replace entire panel
   b. Cut at belt line

   c. Cut at peak of panel

   d. Cut along beads

   e. Use small sections

5. a. Complete panel replacement

   b. Replacement of most of the panel sectioning in small areas

   c. Partial panel replacement--Using half and installing only one section

6. Performance skills will be evaluated according to the criteria listed on the progress chart.

Auto Body
PROGRESS CHART

Section H-1
Major Metal Repair

	Unit I Under Body Measurement				Unit II Frame Alignment							Unit III Bumper & Panel Alignment								
	1	2	3	4	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9
						Straigten & Align							Align							
Job	Unit Test	Use Self-Centering Gauge	Use the Tram Gauge		Unit Test	Mash Frame Damage	Sag Frame Damage	Twist Frame Damage	Sway Frame Damage	Diamond Frame Damage		Unit Test	Bumper with Ends Pushed into the Body	Bumper Hit in Center	Bumper with Ends Pulled Out	Damaged Fender	Damaged Cowl	Damaged Door Panel Using VacuumEquipment	Side Damage	Top
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4
85% Correct																	
According to Manufacturer's Recommended Use																	
According to Manufacturer's Recommended Use																	
85% Correct																	
According to Frame Specification Manuals																	
According to Frame Specification Manuals																	
According to Frame Specification Manuals																	
According to Frame Specification Manuals																	
According to Frame Specification Manuals																	
85% Correct																	
According to Original Specifications of Contour																	
According to Original Specifications of Contour																	
According to Original Specifications of Contour																	
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According to Original Specifications of Contour																	
According to Original Specifications of Contour																	
According to Original Specifications of Contour																	
According to Original Specifications of Contour																	

Auto Body

PROGRESS CHART

Section H-2
Major Metal Repair (continued)

	Unit III Bumper & Panel Alignment (Continued)		Unit IV Body Panel Replacement																	
	10	11	1	2	3	4	5	6	7	8	9	10	11	12	13					
				Remove & Replace						Remove & Replace										
Job	Align Rear Section Damage	Unit Test	Replace a Front Fender & Grill	Front End Assembly	Hood or Deck Lid	Door	Repanel a Door	Replace a Rocker Panel	New Quarter Panel & Lower Deck Panel	Used Quarter Panel	New Top Panel	Used Top Panel	Remove & Install a Rear Body Clip							
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

	Accuracy According to Original Specifications of Contour		85% Correct	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications	See Manufacturer's Specifications						
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SANDING PAINTED SURFACES
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with sanding painted surfaces and determine the sanding procedures necessary to prepare the surface for refinishing. He should be able to featheredge, block sand, hand sand, and use power sanding equipment to prepare the surface for paint. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with sanding to a list of definitions.
2. State the purpose of featheredging.
3. Name the three purposes of sanding.
4. List two major problems solved by wet sanding.
5. List three major advantages of dry sanding.
6. List four tips on hand sanding that will result in a better refinishing job.
7. Write two steps that must be accomplished before starting the sanding procedure.
8. Describe the way an orbital sander should be held against the surface.
9. Demonstrate the ability to:
    a. Featheredge.
    b. Wet sand for a complete paint job.
    c. Dry sand for a complete paint job.
    d. Sand for a spot repair.
    e. Sand for a panel repair.
    f. Scuff sand a surface.

SANDING PAINTED SURFACES
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in job sheets.
- G. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency masters
  - 1. TM 1--Back Sanding
  - 2. TM 2--Featheredge
- D. Job sheets
  - 1. Job Sheet #1--Featheredging
  - 2. Job Sheet #2--Wet Sanding For a Complete Paint Job

3. Job Sheet #3--Dry Sand For a Complete Paint Job

4. Job Sheet #4--Sand for a Spot Repair

5. Job Sheet #5--Sand for a Panel Repair

6. Job Sheet #6--Scuff Sand a Surface

E. Test

F. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Company, 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

C. MacPherson, Robert C. *Collison Repair Guide.* New York: McGraw-Hill Inc., 1971.

D. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Toboldt, Bell. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

F. *Automotive Refinishing Manual S-ARMF (385) JPI.* St. Paul, Minnesota: 3M Minnesota Mining and Manufacturing Co.

G. *Automotive Paint Refinishing.* Dearborn, Michigan: Ford Division National Service Office, 1970.

SANDING PAINTED SURFACES
UNIT I

INFORMATION SHEET

I. Terms and definitions (Transparencies 1 and 2)

A. Back sand--Sanding back from a featheredge area when preparing for primer surfacer application

B. Chalking--Formation on a finish caused by pigmented powder no longer held by the binder; finish looks dull

C. Checking--Small, irregular cracks going partly or completely through a paint film

D. Chipping--Small segments of topcoat that have broken away from the finish resulting in loss of adhesion

E. Cracking--Formation of cracks in a paint film

F. Featheredge--Tapered paint edge from base metal to topcoat

G. Fre-cut--Sandpaper having a zinc stearate coating which tends to prevent clogging when dry sanding

H. Grit--Abrasive coating on sandpaper

I. Oxidation--Combining the oxygen from the air with the paint to dry and harden enamel over a period of several weeks

(NOTE: The chalking (surface powder) of a paint film, that takes place in the aging of the film, is also a form of oxidation.)

J. Sanding--Operation using abrasive paper to sand the automobile leaving it smooth and leaving fine scratches to provide a "tooth" so the new paint will adhere to the old finish

K. Sanding block--Hard, flexible block to provide a smooth backing for hand sanding

L. Sand scratches--Marks made in metal or the old finish by abrasives and also those showing in the finish coat due to lack of fill or sealing

M. Squeegee--Rubber block used to wipe off wet sanded areas or to apply putty

N. Wet or dry--Type of sandpaper used to sand automobile finishes using either the wet application or dry application

(NOTE: Liquids will not dissolve the glue which holds the grit to the paper.)

INFORMATION SHEET

II. Purpose of featheredging--To prevent a broken edge from showing through the new paint by gradually tapering the old paint finish to the base metal thus providing an uninterrupted smooth surface

III. Purposes of sanding

  A. Obtain a smooth surface for the new paint

  B. Provide a "tooth" for new paint adhesion

  C. Remove defects such as sand pits, scratches, and dirt in the old paint

IV. Major problems solved by wet sanding

  A. Prevents paper clogging

  B. Continued rinsing of the surface allows the painter to see and check sanding progress

V. Major advantages of dry sanding

  A. Faster than the wet process

  B. Does not require remasking of panels due to tape and paper getting wet in the wet process

  C. Keeps work area safer by eliminating wet floor conditions

VI. Tips on hand sanding

  A. Never sand in the spray booth

  B. Always use a sanding block or pad to distribute pressure evenly over the entire area

  C. Sand in one direction only

  D. Let the sandpaper do most of the work

  (NOTE: Too much pressure will cause sandpaper to clog and produce sand scratches.)

VII. Steps that must be accomplished before sanding

  A. Wash the entire surface to be refinished with water and detergent

  B. Clean the entire surface to be refinished with wax and grease remover

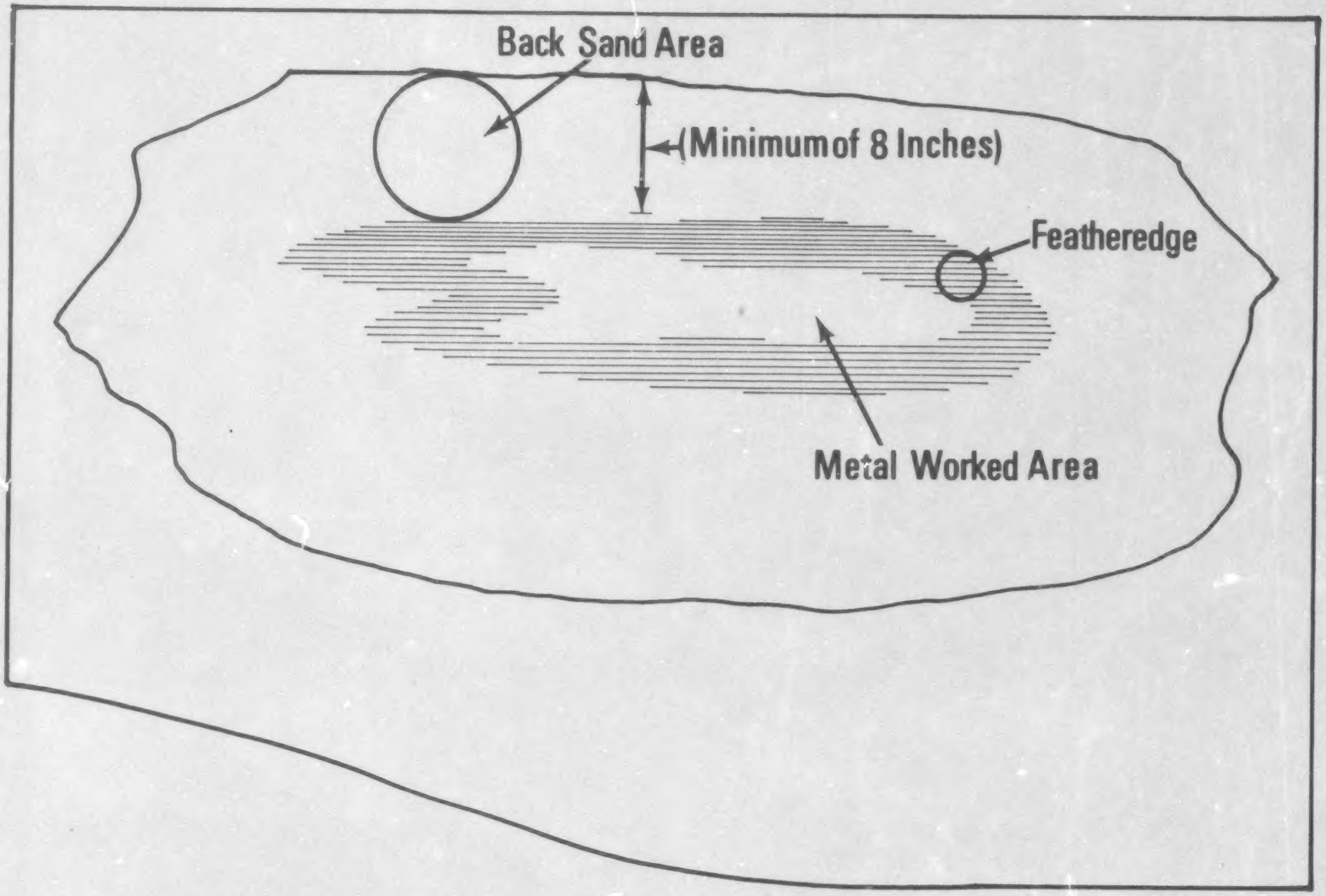
VIII. Description of the way an orbital sander should be held

  A. Hold orbital sander flat on the surface

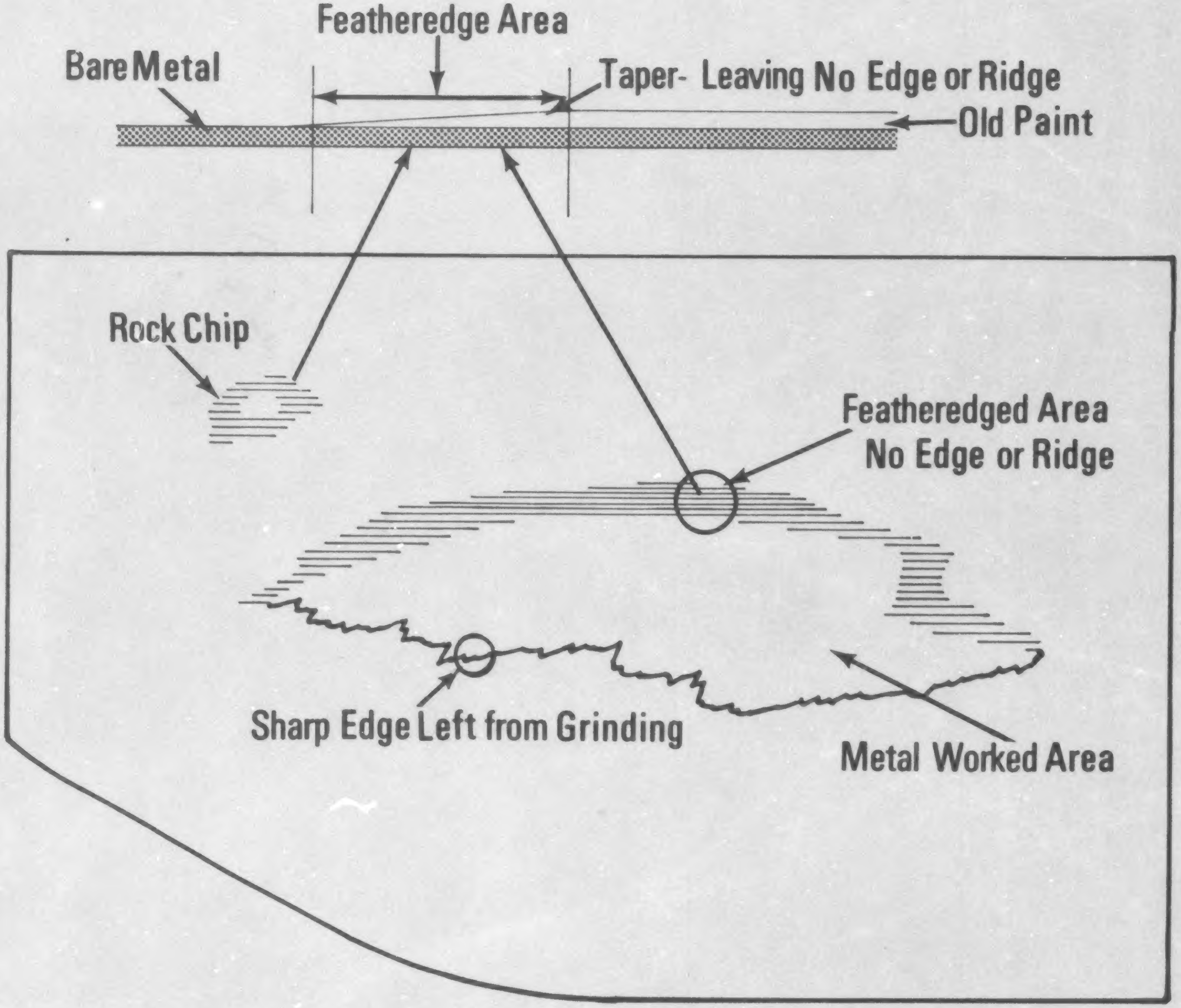
  B. Do not allow or use the edge of the disc to sand or featheredge

  (NOTE: This causes the base surface to be damaged and requires total surface removal.)

Back Sanding


Back Sand Area
(Minimum of 8 Inches)
Featheredge
Metal Worked Area

Featheredge


Featheredge Area
Bare Metal
Taper- Leaving No Edge or Ridge
Old Paint
Rock Chip
Featheredged Area
No Edge or Ridge
Sharp Edge Left from Grinding
Metal Worked Area

SANDING PAINTED SURFACES
UNIT I

JOB SHEET #1--FEATHEREDGING

I. Tools and materials needed

  A. General hand tool set

  B. Sanding block

  C. Orbital sander

  D. Power sander

  E. Sandpaper (assortment)

  F. Discs (assortment)

  G. Discs adhesive

II. Procedure

  A. Clean areas to be featheredged

    1. Wash with detergent and water

    2. Clean with wax and grease remover

  B. Protect areas which could be damaged from featheredging by removing or taping

    1. Moldings and trim

    2. Adjacent panels

    3. Glass

  C. Sand broken paint edge until smooth

    1. Choose method

      a. Hand

      b. Sanding block

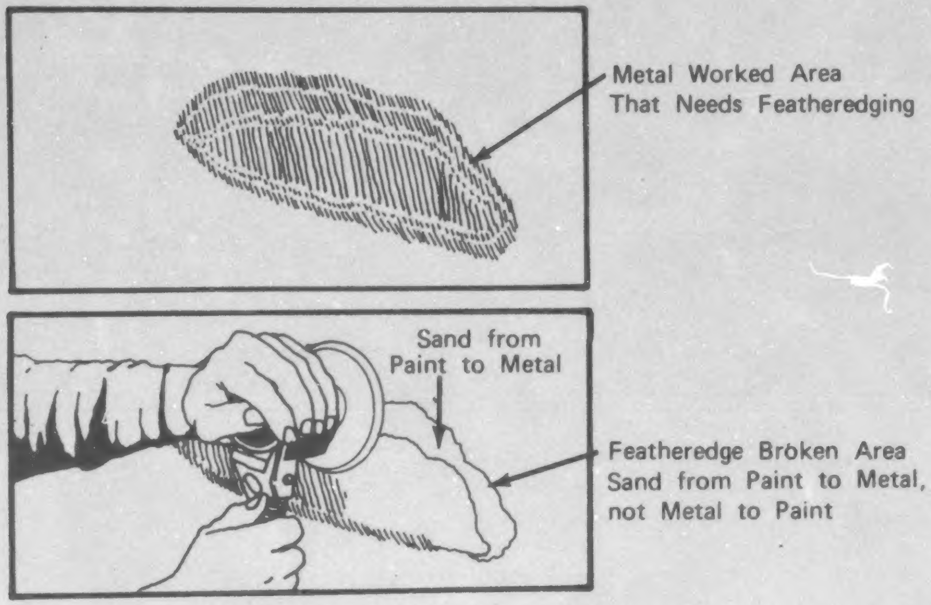
      c. Orbital sander

      d. Power sander

JOB SHEET #1

2. Sand paint from painted surface back into damaged area (Figure 1)

FIGURE 1

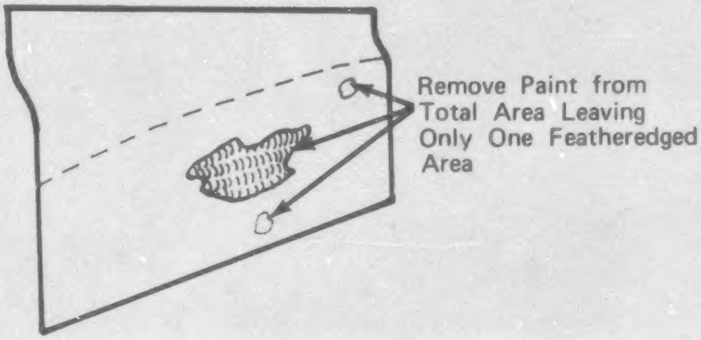

Metal Worked Area
That Needs Featheredging
Sand from
Paint to Metal
Featheredge Broken Area
Sand from Paint to Metal,
not Metal to Paint

(CAUTION: Always wear goggles or safety glasses and a respirator when working with power sanders.)

D. Check area to be sure all grinder scratches have been removed from paint

(NOTE: If several areas need to be featheredged in the same panel, remove the paint from the total area.) (Figure 2)

FIGURE 2


Remove Paint from
Total Area Leaving
Only One Featheredged
Area

SANDING PAINTED SURFACES
UNIT I

JOB SHEET #2--WET SANDING FOR A COMPLETE PAINT JOB

I. Tools and materials needed

A. General hand tool set

B. Sanding block

C. Orbital sander

D. Power sander

E. Water bucket

F. Sponge

G. Sandpaper (assortment)

H. Discs (assortment)

I. Disc adhesive

J. Detergent

K. Wax and grease remover

L. Scuffing pads

M. Masking tape

II. Procedure

A. Wash under hood

(NOTE: Protect carburetor, ignition, and oil inlet from water.)

B. Wash door jams

C. Wash under deck lid and deck lid jam

D. Wash exterior body

E. Clean all surfaces to be painted with wax and grease remover

(NOTE: This may have been done prior to having metal work done. If areas have not been cleaned, do not clean bare metal areas with wax and grease remover. Painted areas only are to be cleaned with wax and grease remover.)

JOB SHEET #2

F. Featheredge vehicle (See Job Sheet #1.)

G. Back sand around featheredge areas using wet or dry sandpaper

H. Mask for primer (See Section I, Unit III.)

I. Treat metal with metal conditioner and clean area

J. Apply primer surfacer (See Unit IV, Job Sheet #3.)

K. Remove moldings and trim

(NOTE: This can be accomplished during the application of primer surfacer.)

L. Block sand primer

M. Reprime blocked areas

N. Sand vehicle

1. Top
2. Right doors
3. Rear body panels
4. Left doors
5. Front end assembly

(NOTE: Rinse each area thoroughly and dry with towels. Do not allow sludge to dry on surface. This could cause paint failure. Do not leave an area until all sanding and cleaning is accomplished.)

O. Sand

1. Door jams
2. Under hood and front fender jams
3. Under deck lid and deck lid jams

(NOTE: Jams are sanded when a change of color is indicated. When color is not changed, scuff pad or steel wool exposed areas only.)

P. Wash automobile

1. Exterior
2. Door jams, under hood, and deck lid areas

SANDING PAINTED SURFACES
UNIT I

JOB SHEET #3--DRY SAND FOR A COMPLETE PAINT JOB

I. Tools and materials needed

   A. General hand tool set

   B. Sanding block

   C. Orbital sander

   D. Power sander

   E. Sandpaper (assortment)

   F. Discs (assortment)

   G. Disc adhesive

   H. Detergent

   I. Wax and grease remover

   J. Scuffing pads

   K. Masking tape

II. Procedure

   A. Wash under hood

      (NOTE: Protect carburetor, ignition, and oil inlet from water.)

   B. Wash door jams

   C. Wash under deck lid and deck lid jams

   D. Wash exterior body

   E. Clean all surfaces to be painted with wax and grease remover

      (NOTE: This may have been done prior to having metal work done. If areas have not been cleaned, do not clean bare metal areas with wax and grease remover. Painted areas only are to be cleaned with wax and grease remover.)

   F. Featheredge vehicle (See Job Sheet #1.)

   G. Back sand around all featheredged areas by hand or orbital sander

JOB SHEET #3

H. Mask for primer

I. Treat metal with metal conditioner and clean area

(NOTE: Because of high dust concentration due to dry sanding, be sure area is cleaned properly.)

J. Apply primer surfacer (See Unit IV, Job Sheet #3.)

K. Remove moldings and trim

(NOTE: This can be accomplished during the application of primer surfacer.)

L. Block sand primer

(NOTE: Block sanding can be accomplished using air files in the dry sand application.)

M. Reprime blocked areas

N. Sand vehicle

1. Sand each panel thoroughly with orbital sander

2. Hand sand around moldings, trim, drip rails, and body seams carefully

   (NOTE: Most paint job failures are the result of improper sanding around these areas. Do not fail to do this sanding properly.)

3. Clean each panel thoroughly

   (IMPORTANT: Do not leave an area until all sanding and cleaning is accomplished.)

4. Sanding order

   a. Top

   b. Right side body panels

   c. Rear body panels

   d. Left side body panels

   e. Front end assembly

JOB SHEET #3

O. Sand

1. Door jams

2. Under hood and front fender jams

3. Under deck lid and trunk jams

   (NOTE: Jams are sanded when a change of color is indicated. When color is changed, scuff pad or steel wool exposed areas only.)

P. Wash automobile

1. Exterior

2. Door jams, under hood, and deck lid areas

SANDING PAINTED SURFACES
UNIT I

JOB SHEET #4--SAND FOR A SPOT REPAIR

I. Tools and materials needed

- A. General hand tool set
- B. Sanding block
- C. Orbital sander
- D. Power sander
- E. Water bucket
- F. Sponge
- G. Sandpaper (assortment)
- H. Discs (assortment)
- I. Disc adhesive
- J. Detergent
- K. Wax and grease remover
- L. Scuffing pad
- M. Masking tape

II. Procedure

- A. Wash all panels to be spotted
- B. Clean all panels to be spotted with wax and grease remover

  (NOTE: If metal work has been accomplished, do not wash bare metal with wax and grease remover.)
- C. Featheredge area to be spotted
- D. Back sand around featheredged area a minimum of eight inches

  (NOTE: Wet sand or dry sand application may be used.)
- E. Mask for primer
- F. Treat bare metal only with metal conditioner and clean area

JOB SHEET #4

G. Apply primer surfacer (See Unit IV, Job Sheet #3.)

H. Block sand

I. Reprime as necessary

J. Resand area to be spotted

K. Compound entire panel to be spotted

(NOTE: If spot repair is at the edge of a panel, compound the adjacent panel in case blending is necessary. Compound total surface including primer surfacer.)

L. Clean total area with enamel reducer

SANDING PAINTED SURFACES
UNIT I

JOB SHEET #5--SAND FOR A PANEL REPAIR

I. Tools and materials needed

   A. General hand tool set

   B. Sanding block

   C. Orbital sander

   D. Power sander

   E. Water bucket

   F. Sponge

   G. Sandpaper (assortment)

   H. Discs (assortment)

   I. Disc adhesive

   J. Detergent

   K. Wax and grease remover

   L. Scuffing pad

   M. Masking tape

II. Procedure

   A. Wash all panels to be refinished

   B. Clean all panels to be refinished with wax and grease remover

      (NOTE: If metal work has been accomplished, do not wash bare metal with wax and grease remover.)

   C. Featheredge area to be spotted

   D. Back sand around featheredged area a minimum of eight inches

      (NOTE: Wet sand or dry sand application may be used.)

   E. Mask for primer

   F. Treat bare metal only with metal conditioner and clean area

JOB SHEET #5

G. Apply primer surfacer (See Unit IV, Job Sheet #3.)

H. Block sand

I. Reprime as necessary

J. Sand panels to be refinished

(NOTE: Rinse each panel thoroughly and dry with towels. Do not allow sludge (wet sand) or dust (dry sand) to accumulate on surface. Do not leave a panel until all sanding and cleaning is accomplished.)

K. Compound blend areas where moldings and body seams will not allow masking

(NOTE: Compounding is necessary to remove road film and oxidation to allow color match in the blend area. Compounding will provide a "tooth" for the new paint to hold to.)

L. Clean total area with enamel reducer

SANDING PAINTED SURFACES
UNIT I

JOB SHEET #6--SCUFF SAND A SURFACE

I. Tools and materials needed

  A. General hand tool set

  B. Water bucket

  C. Sponge

  D. Sandpaper (assortment)

  E. Detergent

  F. Wax and grease remover

  G. Scuffing pad or steel wool

II. Procedure

  A. Wash entire surface to be scuff sanded with soap and water

  B. Clean surface with wax and grease remover

  C. Lightly sand surface until dull with 400 grit or finer sandpaper using either dry or wet method

  (NOTE: Scuffing pad or steel wool is used by some painters for this operation.)

  D. Rinse area thoroughly and dry with towels

  E. Use compressed air to dry cracks and around moldings

  (NOTE: Do not touch surface after cleaning. This will prevent paint failure due to skin oils, silicone, or water. Scuff sanding is used to sand primers and some sealers when dirt nibs need removing before paint application.)

SANDING PAINTED SURFACES
UNIT I

TEST

1. Match the following terms with the correct definition.

_____a. Small segments of topcoat that have broken away from the finish resulting in loss of adhesion

_____b. Formation of cracks in a paint film

_____c. Hard, flexible block to provide a smooth backing for hand sanding

_____d. Marks made in metal or the old finish by abrasives and also those showing in the finish coat due to lack of fill or sealing

_____e. Type sandpaper used to sand automobile finishes using either the wet application or dry application

_____f. Abrasive coating on sandpaper

_____g. Small, irregular cracks going partly or completely through a paint film

_____h. Tapered paint edge from base metal to topcoat

_____i. Rubber block used to wipe off wet sanded areas or to apply putty

_____j. Sandpaper having a zinc stearate coating which tends to prevent clogging when dry sanding

_____k. Sanding back from a featheredge area when preparing for primer surfacer application

1. Back sand
2. Chalking
3. Checking
4. Chipping
5. Cracking
6. Featheredge
7. Fre-cut
8. Grit
9. Oxidation
10. Sanding
11. Sanding block
12. Sand scratches
13. Squeegee
14. Wet or dry

_____l. Combining the oxygen from the air with the paint to dry and harden enamel over a period of several weeks

_____m. Formation on a finish caused by pigmented powder no longer held by the binder; finish looks dull

_____n. Operation using abrasive paper to sand the automobile leaving it smooth and leaving fine scratches to provide a "tooth" so the new paint will adhere to the old finish

2. State the purpose of featheredging.

3. Name the three purposes of sanding.

   a.

   b.

   c.

4. List two major problems solved by wet sanding.

   a.

   b.

5. List three major advantages of dry sanding.

   a.

   b.

   c.

6. List four tips on hand sanding that will result in a better refinishing job.

   a.

   b.

   c.

   d.

7. Write two steps that must be accomplished before starting the sanding procedure.

   a.

   b.

8. Describe the way an orbital sander should be held against the surface.

9. Demonstrate the ability to:

   a. Featheredge.

   b. Wet sand for a complete paint job.

   c. Dry sand for a complete paint job.

   d. Sand for a spot repair.

   e. Sand for a panel repair.

   f. Scuff sand a surface.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

SANDING PAINTED SURFACES
UNIT I

ANSWERS TO TEST

1. a. 4
   b. 5
   c. 11
   d. 12
   e. 14
   f. 8
   g. 3
   h. 6
   i. 13
   j. 7
   k. 1
   l. 9
   m. 2
   n. 10

2. To prevent a broken edge from showing through the new paint by gradually tapering the old paint finish to the base metal thus providing an uninterrupted smooth surface

3. a. Obtain a smooth surface for the new paint
   b. Provide a "tooth" for new paint adhesion
   c. Remove defects such as sand pits, scratches, and dirt in the old paint

4. a. Prevents paper clogging
   b. Continued rinsing of the surface allows the painter to see and check sanding progress

5. a. Faster than the wet process
   b. Does not require remasking of panels due to tape and paper getting wet in the wet process
   c. Keeps work area safer by eliminating wet floor conditions
6. a. Never sand in the spray booth
   b. Always use a sanding block or pad to distribute pressure evenly over the entire area
   c. Sand in one direction only
   d. Let the sandpaper do most of the work
7. a. Wash the entire surface to be refinished with water and detergent
   b. Clean the entire surface to be refinished with wax and grease remover
8. Description should include:
   a. Hold orbital sander flat on the surface
   b. Do not allow or use the edge of the disc to sand or featheredge
9. Performance skills will be evaluated according to the criteria listed on the progress chart.

STRIPPING PAINTED SURFACES
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define the terms associated with removal of paint and determine the best method to use in removing paint from an automobile when necessary. He should be able to use the correct method to remove the finish from the surface. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with paint stripping to a list of definitions.
2. List four methods for removing old finishes.
3. Describe the three steps in using paint remover.
4. Describe the result of holding the sander flat on the surface.
5. Demonstrate the ability to:
    a. Remove paint with a sander.
    b. Remove lacquer paint with lacquer removing solvent.
    c. Remove paint with paint remover.

STRIPPING PAINTED SURFACES
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Discuss terminal and specific objectives.
- D. Discuss information sheet.
- E. Demonstrate and discuss procedures outlined in job sheets.
- F. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Job sheets
  1. Job Sheet #1--Remove Paint with a Sander
  2. Job Sheet #2--Remove Lacquer Paint with Lacquer Removing Solvent
  3. Job Sheet #3--Remove Paint with Paint Remover
- D. Test
- E. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques*. First Edition. Wilmington Delaware: E. T. duPont de Nemours and Company, 1969.

B. *Automotive Paint Refinishing*. Dearborn, Michigan: Ford Division National Service Office, 1970.

STRIPPING PAINTED SURFACES
UNIT II

INFORMATION SHEET

I. Terms and definitions

  A. Blistering--The formation of small bubbles in the finish which may occur between the metal and undercoats or between the undercoats and topcoat

  B. Corrosion--A chemical reaction which results in deterioration of a metal

  Example: Rust

  C. Gouging (Scarring)--Resulting from improper use of the grinders or power sanders when removing finishes

  D. Hot spot--Paint failure resulting from not neutralizing or completely removing paint remover from the surface

  E. Lacquer removing solvent--Solvent used to remove and featheredge lacquer finishes

  (NOTE: This solvent will not disturb factory applied primers.)

  F. Neutralizing--Destroys the effectiveness of paint remover to eliminate hot spot during refinishing

  (NOTE: Most paint removers are self-neutralizing with water.)

  G. Paint failure--Failure in paint caused by checking, cracking, chipping, crazing, poor adhesion, or other defects requiring removal before refinishing can be accomplished

  H. Paint remover--A fast acting blend of solvents used to remove enamels, lacquers, and varnishes

II. Methods for removing old finishes

  A. Sanding

  B. Paint remover

  C. Lacquer removing solvent

  D. Torch (burning)

III. Steps in using paint remover

  A. Apply a heavy coat of paint remover using a brush

  B. Allow finish to lift (enamel) or soften (lacquer)

  C. Use scraper or wire brush and wash clean with water

INFORMATION SHEET

IV. Result of holding the sander flat on the surface--Sander may twist and fly out of worker's hand resulting in injury to worker and damage to vehicle and machine

STRIPPING PAINTED SURFACES
UNIT II

JOB SHEET #1--REMOVE PAINT WITH A SANDER

I. Tools, equipment, and supplies

  A. Grinder or sander

  B. Polisher

  C. Featheredge base wheels

  D. Sanding discs

  E. Sandpaper

  F. Water pail

  G. Detergent

  H. Wax and grease remover

  I. Masking or protective tape

II. Procedure:

  A. Prepare the surface for paint removal

    1. Wash the automobile as necessary with detergent and water

    2. Remove all necessary moldings, trim, and emblems

    3. Clean the surface thoroughly with wax and grease remover

    4. Mask moldings, trim, and emblems which can not be removed and that need to be protected from the sander

      a. Use several strips of masking tape or,

      b. Use protective tape

  B. Sand paint from panels (Figure 1 on next page)

  (CAUTION: Wear eye protection)

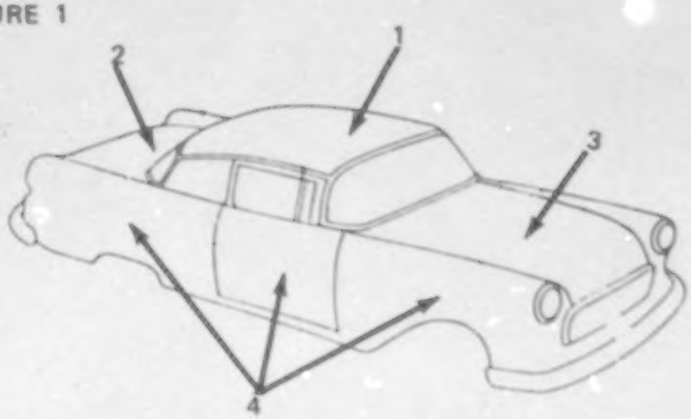
    1. Top

    2. Rear body sections

JOB SHEET #1

3. Front body sections
4. Sides

FIGURE 1



(NOTE: Work from upper panels to lower panels. This keeps all dust moving down providing a cleaner job. Clean and finish each panel as you go.)

(IMPORTANT: Sanding discs create heat when sanding. This will buckle and warp large body panels if care is not taken to sand the surface properly. Do not sand beyond primer with course discs. Use a featheredge attachment and fine paper to remove prime coat from surface.)

C. Use small oscillator sander or hand sand around all trim moldings and emblems

(IMPORTANT: Hand sand around door glass, windshields, backglasses, and places too small to use machines. Never chance damage to glass, moldings, and trim.)

D. Clean the automobile interior and exterior of all sanding dust

STRIPPING PAINTED SURFACES
UNIT II

JOB SHEET #2--REMOVE LACQUER PAINT WITH LACQUER REMOVING SOLVENT

I. Tools, equipment, and supplies

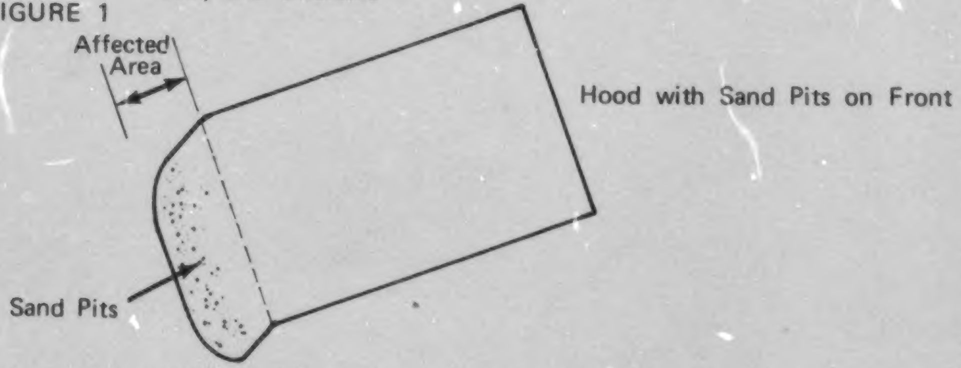
- A. Masking tape
- B. Wax and grease remover
- C. Water pail
- D. Detergent
- E. Sandpaper
- F. Shop towels
- G. Lacquer removing solvent

II. Procedure

A. Prepare the surface for paint removal (Figure 1)

1. Wash the affected panel or area with detergent and water, rinse
2. Clean the surface with wax and grease remover
3. Mask the surfaces that are not going to be removed including molding, trim, and emblems

FIGURE 1



(IMPORTANT: Lacquer removing solvent will dissolve most plastics. Do not use or allow it to come in contact with plastic parts.)

(NOTE: Lacquer removing solvent is used for spot or panel repair only. DO NOT ATTEMPT to strip an entire automobile using this method.)

(CAUTION: Wear rubber gloves as solvent could be toxic to skin. Read label directions.)

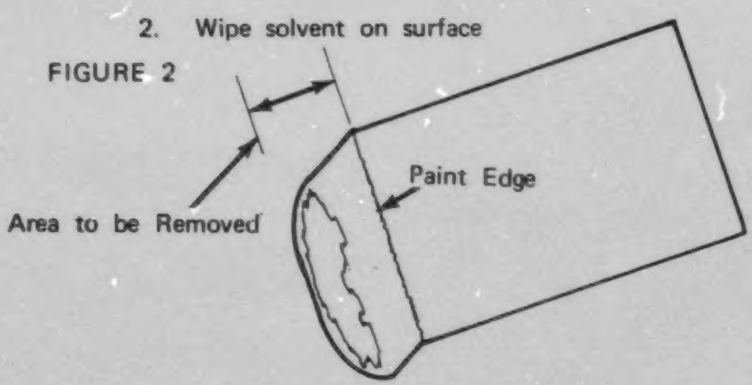
JOB SHEET #2

B. Remove paint from affected area (Figure 2)

1. Saturate a shop towel with lacquer removing solvent

2. Wipe solvent on surface

FIGURE 2



a. Wipe in one direction only

b. Use clean surface on shop towel each time panel surface is contacted

c. Do not wipe beyond area affected which needs to be removed

d. Wipe surface until all paint has been removed, leaving only the factory undercoat (primer)

e. Allow surface to dry

1. In the case of a spot repair, sand paint edge to provide proper featheredge

(NOTE: See Figure 2.)

2. Remove all paint from small panel areas

(NOTE: This includes the bottom one-half of doors, quarter panel, and other areas.)

3. Scuff, sand, and refinish as necessary

C. Clean the affected panels and adjacent areas as necessary for refinishing

STRIPPING PAINTED SURFACES
UNIT II

JOB SHEET #3--REMOVE PAINT WITH PAINT REMOVER

I. Tools, equipment, and supplies

  A. Oscillating sander

  B. Putty knife

  C. Wire brush

  D. Paint remover

  E. Water pail

  F. Sandpaper

  G. Masking tape

  H. Paint brush

II. Procedure:

  A. Prepare the surface for paint removal

    1. Wash the automobile as necessary with detergent and water

    2. Remove all necessary moldings, trim, and emblems

    3. Clean the surface with wax and grease remover

    4. Mask moldings, trim, and emblems which can not be removed

    (IMPORTANT: Paint remover will dissolve many plastics. Do not use or allow it to come in contact with plastics.)

    (CAUTION: Paint remover is toxic. Wear rubber gloves and use in a well ventilated area.)

  B. Brush paint remover on surface

    1. Enamel paint will lift off of surface

    2. Lacquer paint will soften

    (NOTE: Brush only area that can be easily cleaned, usually about one foot square. If too much area is coated, the paint remover will harden requiring additional work and a poor quality repair.)

JOB SHEET #3

C. Remove paint from surface

   1. Scrape off with stiff putty knife

   2. Brush with a hand wire brush

      (CAUTION: Wear goggles and protective clothing when brushing surface.)

      (IMPORTANT: If surface has had repair, paint remover may soften body filler. Affected areas will require refilling.)

D. Wash surface with water

   (NOTE: Water will cleanse surface and neutralize the paint remover.)

E. Sand surface with coarse sandpaper

   1. Use oscillating sander for large areas

      (CAUTION: Wear goggles, protective clothing, and respirator when sanding.)

   2. Hand sand around moldings, emblems, and trim

F. Clean each panel after completion

   (NOTE: Always finish each panel before continuing to the next. This will result in a professional removal job.)

STRIPPING PAINTED SURFACES
UNIT II

TEST

1. Match the following terms with the correct definition.

_____a. The formation of small bubbles in the finish which may occur between the metal and undercoats or between the undercoats and topcoat

_____b. A chemical reaction which results in deterioration of a metal

_____c. Resulting from improper use of the grinders or power sanders when removing finishes

_____d. Paint failure resulting from not neutralizing or completely removing paint remover from the surface

_____e. Solvent used to remove and featheredge lacquer finishes

_____f. Destroys the effectiveness of paint remover to eliminate hot spot during refinishing

_____g. Failure in paint caused by checking, cracking, chipping, crazing, poor adhesion, or other defects requiring the removal before refinishing can be accomplished

_____h. A fast acting blend of solvents used to remove enamels, lacquers, and varnishes

1. Neutralizing
2. Corrosion
3. Lacquer removing solvent
4. Paint failure
5. Hot spot
6. Paint remover
7. Gouging (Scarring)
8. Blistering

2. List four methods for removing old finishes.

a.

b.

c.

d.

3. Describe the three steps in using paint remover.

   a.

   b.

   c.

4. Describe the result of holding the sander flat on the surface.

5. Demonstrate the ability to:

   a. Remove paint with sander.

   b. Remove lacquer paint with lacquer removing solvent.

   c. Remove paint with paint remover.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

STRIPPING PAINTED SURFACES
UNIT II

ANSWER TO TEST

1. a. 8
   b. 2
   c. 7
   d. 5
   e. 3
   f. 1
   g. 4
   h. 6
2. a. Sanding
   b. Paint remover
   c. Lacquer removing solvent
   d. Torch (burning)
3. a. Apply a heavy coat of paint remover using a brush
   b. Allow finish to lift (enamel) or soften (lacquer)
   c. Use scraper or wire brush and wash clean with water
4. Sander may twist and fly out of worker's hand resulting in injury to worker and damage to vehicle and machine
5. Performance skills will be evaluated according to the criteria listed on the progress chart.

MASKING
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define the terms associated with masking and determine the best method of masking for the job to be performed. He should be able to mask for primer, spot repairs, panel repair, and for a complete paint job. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with masking to a list of definitions.
2. Describe the three methods of masking with paper.
3. List the three rules for application of masking paper and tape.
4. Tell when masking should be removed from enamel.
5. Tell when masking should be removed from lacquer topcoats or undercoats.
6. Demonstrate the ability to:
    a. Mask for primer.
    b. Mask for a spot repair.
    c. Mask for a panel repair.
    d. Mask for a complete paint job.

MASKING
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Discuss terminal and specific objectives.
- D. Discuss information sheet.
- E. Demonstrate and discuss procedures outlined in job sheets.
- F. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Job sheets
  - 1. Job Sheet #1--Mask for Primer
  - 2. Job Sheet #2--Mask for a Spot Repair
  - 3. Job Sheet #3--Mask for a Panel Repair
  - 4. Job Sheet #4--Mask for a Complete Paint Job

D. Test

E. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* Wilmington, Delaware: E. I. duPont deNemours and Co., Inc., 1970.

B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada, Ltd., 1969.

C. Tait, A. *The Principles of Autobody Repairing and Repainting.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

D. Toboldt, Bill. *Autobody Repairing and Repainting.* Third Edition. South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

MASKING
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Masking–Covering areas on an automobile not to be painted

   B. Masking tape–An automotive tape designed for masking of automobiles for spot repair, panel repair, or all over refinishing

   C. Apron–A piece of paper with a strip of tape on one edge used for masking glass, panels, and other areas that need protection from paint overspray

   D. Masking paper–A specially designed paper which prevents paint from seeping through to protected surfaces

   E. Apron taper–A machine designed to hold masking paper and tape; as the paper is pulled off the roll, the tape is dispensed to the edge of the paper making an apron

   F. Reverse taping–Method used to prevent bleeding of solvents and dulling of the masked finish

II. Methods of masking with paper

   A. Tack the paper in position with several short strips of tape followed with a length of tape as long as the paper; apply one-half of the long strip to the surface and the other half of the width to the paper

   B. Apply the paper and tape using an apron taper

   C. Apply tape to the surface to be masked with one-half of the width of tape applied to the surface; slip the paper under the open edge and press down to hold the paper

III. Rules for application of masking paper and tape

   A. Surface to be taped must be clean and dry

   B. Tape must not overlap any surface to be painted

   (NOTE: Do not stretch tape. Stretching results in creeping or crawling.)

   C. When spraying horizontal surface, two layers of paper or reverse taping procedures must be used to prevent bleeding

INFORMATION SHEET

IV. Masking removal from enamel

   A. Normal air dry application–Remove following day

   B. Forced dry–Remove immediately after the finish has been baked

   C. Two-toning–Remove as soon as the first coat has set up

V. Masking removal from lacquer topcoats or undercoats–Remove immediately while film is wet

MASKING
UNIT III

JOB SHEET #1--MASK FOR PRIMER

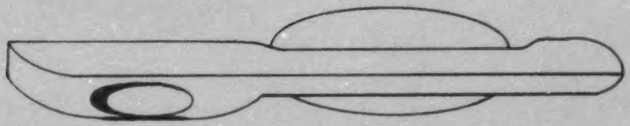
I. Tools and materials needed

- A. Masking tape
- B. Masking paper
- C. Apron taper
- D. Cleaning materials
- E. Towels

II. Procedure

- A. Clean all parts to be masked
- B. Mask all chrome, emblems, trim, and body panels which must be protected from primer overspray
    1. Make a small apron and mask around a door handle (Figure 1)

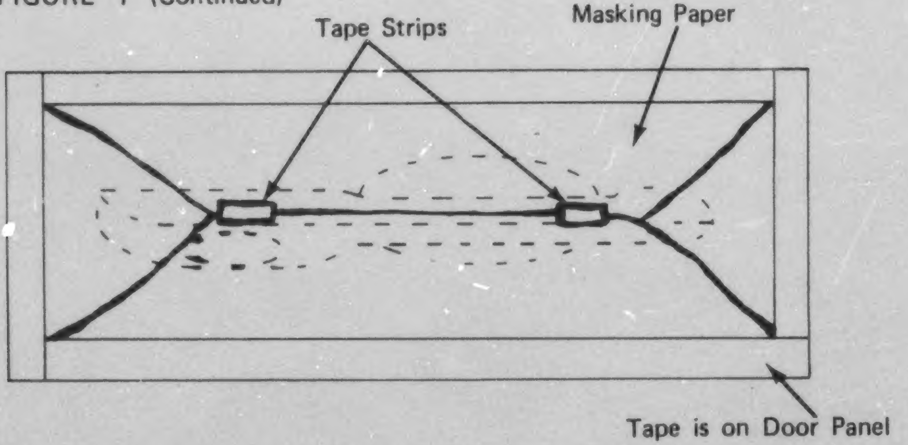
FIGURE 1



Door Handle

JOB SHEET #1

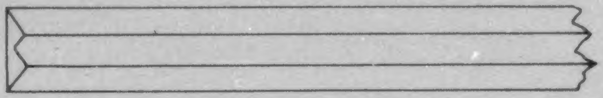
FIGURE 1 (Continued)


Tape Strips
Masking Paper
Tape is on Door Panel

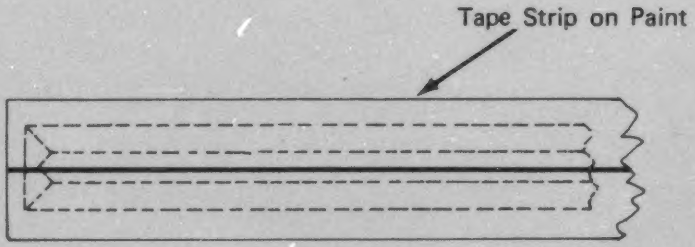
(NOTE: This type of masking will prevent build up on door handle and gasket. When tape is removed, the tape edge left by primer can easily be smoothed with sandpaper.)

2. Mask molding for primer (Figure 2)

FIGURE 2



Molding

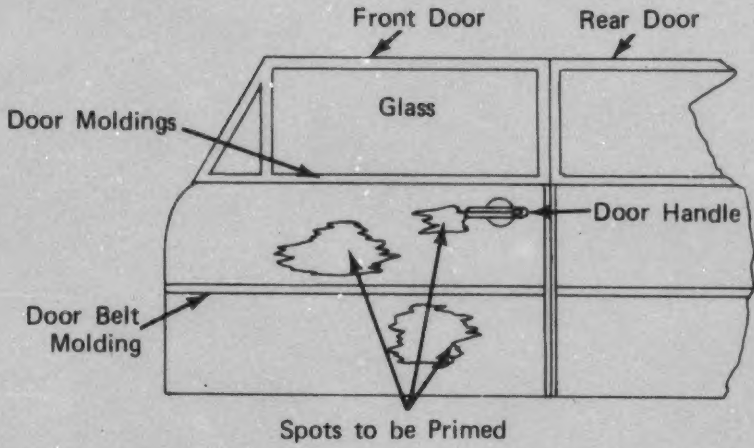

Tape Strip on Paint

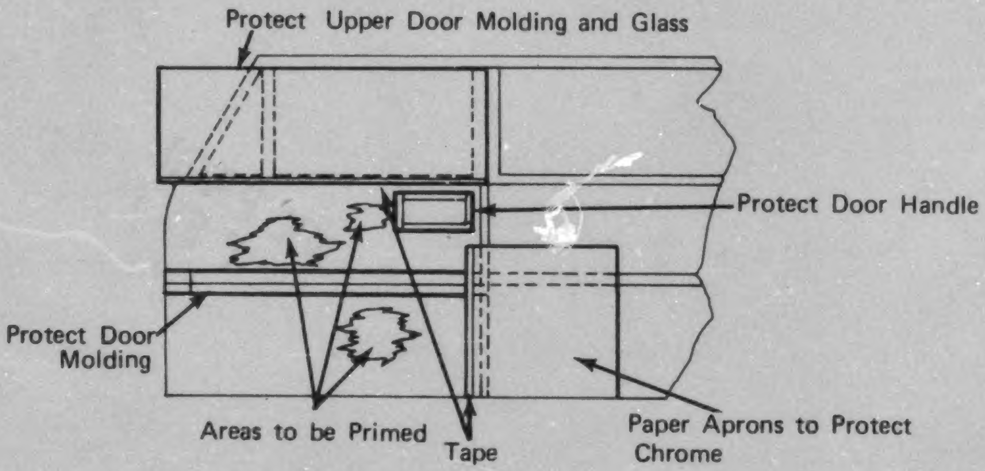
Molding Taped for Primer

JOB SHEET #1

3. Mask a body panel for primer (Figure 3)

FIGURE 3


Front Door
Rear Door
Glass
Door Moldings
Door Handle
Door Belt Molding
Spots to be Primed


Protect Upper Door Molding and Glass
Protect Door Handle
Protect Door Molding
Areas to be Primed
Tape
Paper Aprons to Protect Chrome

C. After priming all areas, remove tape and paper and discard

(NOTE: All body panels can be masked for primer. At no time should primer overspray be allowed to get on any chrome parts or body panels that are not going to be refinished.)

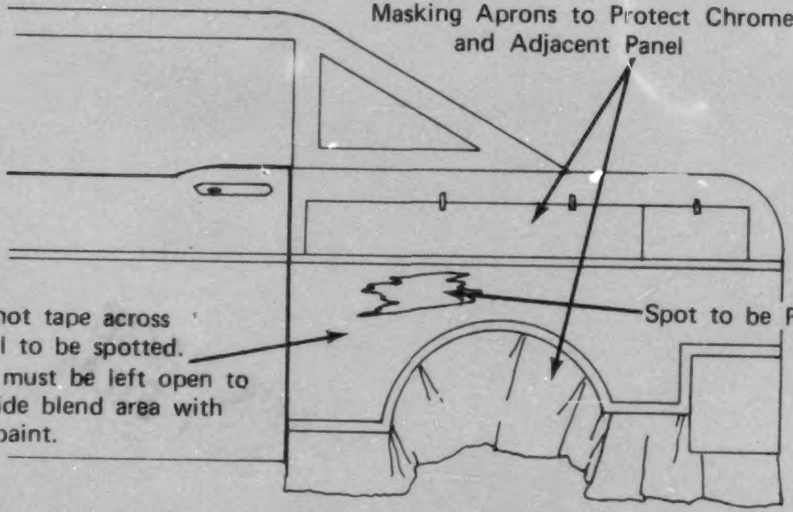
MASKING
UNIT III

JOB SHEET #2--MASK FOR A SPOT REPAIR

I. Tools and materials needed
   - A. Masking tape
   - B. Masking paper
   - C. Apron taper
   - D. Cleaning materials
   - E. Towels

II. Procedure
   - A. Prepare the surface for spot repair
   - B. Clean all chrome, moldings, trim, and adjacent panels
   - C. Mask area to be spotted (Figure 1)
     - 1. Mask moldings
     - 2. Mask adjacent panels

FIGURE 1



Masking Aprons to Protect Chrome and Adjacent Panel

Spot to be Repaired

Do not tape across panel to be spotted. This must be left open to provide blend area with old paint.

(NOTE: Mask all chrome, trim, and panels which need to be protected from overspray. Do not allow tape on panel to be spot repaired. Trim all excess tape around moldings carefully. Do not stretch masking tape. Stretching results in creeping or crawling.)

MASKING
UNIT III

JOB SHEET #3--MASK FOR A PANEL REPAIR

I. Tools and materials needed

   A. Masking tape

   B. Masking paper

   C. Apron taper

   D. Cleaning materials

   E. Towels

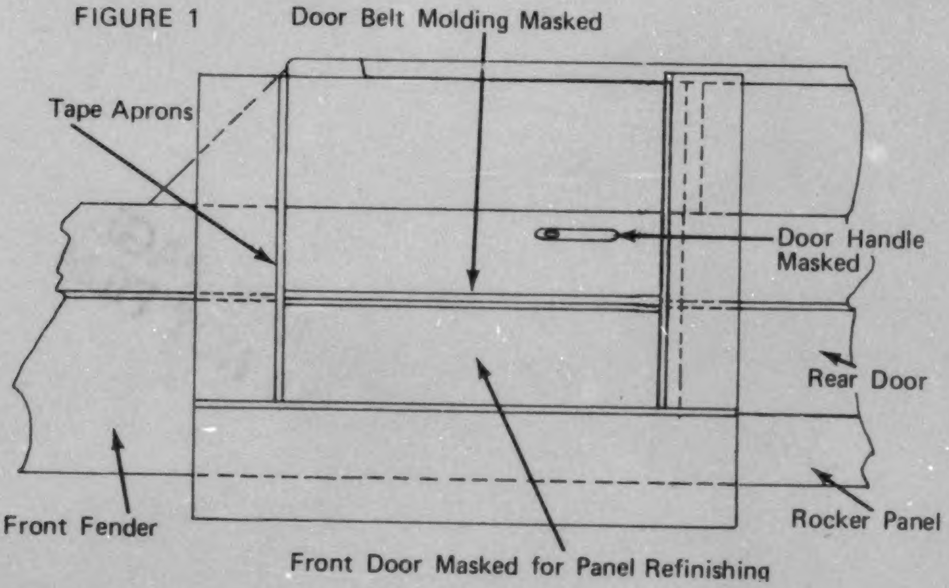
II. Procedure

   A. Prepare the panel for repair

   B. Clean all chrome, moldings, trim, and adjacent panels

   C. Mask panel isolating it from rest of automobile (Figure 1)

FIGURE 1


Door Belt Molding Masked
Tape Aprons
Door Handle Masked
Rear Door
Rocker Panel
Front Fender
Front Door Masked for Panel Refinishing

MASKING
UNIT III

JOB SHEET #4--MASK FOR A COMPLETE PAINT JOB

I. Tools and materials needed

- A. Masking tape
- B. Masking paper
- C. Apron taper
- D. Cleaning materials
- E. Towels

II. Procedure

A. Prepare the automobile for masking

1. Clean all windows
2. Clean chrome moldings and trim
3. Blow car out carefully with compressed air

(NOTE: Check with instructor to see if car is clean enough to be masked. Any dirt or dust trapped at this stage could result in a poor paint job.)

B. Mask off automobile

1. Mask off all glass
2. Mask off chrome moldings
3. Mask all trim

C. Mask each panel separately

(NOTE: Never mask any body panels, doors, trunk lids, or hoods where they will not open. Door jams, hood and trunk jams always need to be cleaned just before refinishing.)

MASKING
UNIT III

TEST

1. Match the following terms associated with masking to the list of definitions provided.

_____a. An automotive tape designed for masking of automobiles for spot repair, panel repair, or all over refinishing

_____b. A specially designed paper which prevents paint from seeping through to protected surfaces

_____c. Method used to prevent bleeding of solvents and dulling of the masked finish

_____d. Covering areas on an automobile not to be painted

_____e. A piece of paper with a strip of tape on one edge used for masking glass, panels, and other areas that need protection from paint overspray

_____f. A machine designed to hold masking paper and tape; as the paper is pulled off the roll, the tape is dispensed to the edge of the paper making an apron

1. Masking
2. Masking tape
3. Apron
4. Masking paper
5. Apron taper
6. Reverse taping

2. Describe the three methods of masking with paper.

a.

b.

c.

3. List the three rules for application of masking paper and tape.

   a.

   b.

   c.

4. Tell when masking should be removed from enamel.

5. Tell when masking should be removed from lacquer topcoats or undercoats.

6. Demonstrate the ability to:

   a. Mask for primer.

   b. Mask for a spot repair.

   c. Mask for a panel repair.

   d. Mask for a complete paint job.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

MASKING
UNIT III

ANSWERS TO TEST

1. a. 2
   b. 4
   c. 6
   d. 1
   e. 3
   f. 5

2. a. Tack the paper in position with several short strips of tape followed with a length of tape as long as the paper; apply one-half of the long strip to the surface and the other half of the width to the paper
   b. Apply the paper and tape using an apron taper
   c. Apply tape to the surface to be masked with one-half of the width of tape applied to the surface; slip the paper under the open edge and press down to hold the paper

3. a. Surface to be taped must be clean and dry
   b. Tape must not overlap any surface to be painted
   c. When spraying horizontal surface, two layers of paper or reverse taping procedures must be used to prevent bleeding

4. a. Normal air dry application--Remove following day
   b. Forced dry--Remove immediately after the finish has been baked
   c. Two-toning--Remove as soon as the first coat has set up

5. Masking removal from lacquer topcoats or undercoats--Remove immediately while film is wet

6. Performance skills will be evaluated according to the criteria listed on the progress chart.

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define the terms associated with spraying automotive finishes and explain the techniques of using the spray gun, of preparing the finishes for use in spraying, and of matching colors when necessary. He should be able to adjust and use paint equipment, prepare and apply undercoats and topcoats, and match colors. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with spraying to a list of definitions.
2. Name the two types of paint booths.
3. List the three functions of a drying room.
4. Name two methods for force drying paint.
5. Name the four items of basic spray equipment that would be adequate for a paint shop.
6. Write the five methods used to maintain an air compressor.
7. List four causes of low air pressure.
8. List three conditions that contaminate air compressor lines.
9. Describe the operation of the air transformer.
10. Describe how the paint gun works.
11. Identify the principle parts of the spray gun.
12. Describe how to regulate the spray pattern.
13. Describe triggering the gun.
14. List the three degrees of thickness of sprayed paint.
15. Name three problems that can occur when the gun is handled improperly.
16. Describe cleaning and care of the spray gun.

17. Name the two coats that make up the automotive finish.

18. List the types of finishes found on automobiles today.

19. Describe how to distinguish between a metallic topcoat and a nonmetallic topcoat.

20. Name the three basic ingredients of a topcoat.

21. Describe the procedure used to identify whether a topcoat is lacquer or enamel.

22. List three causes of color weathering.

23. List three ways to prevent color weathering.

24. Describe the procedure for matching colors.

25. Name the two tones that refinishers need to know for proper color matching.

26. List three aids for systematic tinting.

27. Name two basic causes of poor metallic match.

28. Demonstrate the ability to:

    a. Use the paint gun with proper technique.

    b. Mix paint.

    c. Mix and apply undercoats.

    d. Mix and apply topcoats.

    e. Perform a spot repair.

    f. Perform a panel repair.

    g. Match colors.

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide students with objective sheet.
   B. Provide students with information and job sheets.
   C. Make transparencies.
   D. Discuss terminal and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss procedures outlined in job sheets.
   G. Give test.

II. Students:
   A. Read objective sheet.
   B. Study information sheet.
   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objectives
   B. Information sheet
   C. Transparency masters
      1. TM 1--Spray Gun and Points of Lubrication
      2. TM 2--Spray Gun--External Mix and Internal Mix
      3. TM 3--Spray Patterns
      4. TM 4--Air Transformer and Air Compressor

   5. TM 5--Force Drying Methods
   6. TM 6--Operation of Air Transformer
   7. TM 7--How the Suction Feed Paint Gun Works
   8. TM 8--Principle Parts of the Spray Gun
   9. TM 9--Paint Problems from Improper Handling of Paint Gun

D. Job sheets
   1. Job Sheet #1--Use the Paint Gun With Proper Technique
   2. Job Sheet #2--Mix Paint
   3. Job Sheet #3--Mix and Apply Undercoats
   4. Job Sheet #4--Mix and Apply Topcoats
   5. Job Sheet #5--Perform a Spot Repair
   6. Job Sheet #6--Perform a Panel Repair
   7. Job Sheet #7--Match Colors

E. Test

F. Answers to test

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Company, 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Company of Canada Limited, 1969.

C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

D. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Tait, A., A. G. Deroche, and N. N. Hildebrand. *The Principles of Auto Body Repairing and Repainting.* Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1971.

F. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1972.

G. *Automotive Refinishing Manual S-ARMF (385) JPI.* St. Paul, Minnesota: 3M Minnesota Mining and Manufacturing Company.

H. *Motor Crash Estimating Guide*. March 1970, vol. 2. no. 3. New York: The Harst Corporation.

I. *Ford Autolite Body and Collision Parts Catalog*. AF-7832-72, 1972 Edition.

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

INFORMATION SHEET

I. Terms and definitions (Transparencies 1, 2, 3, and 4)

   A. Spray gun--A tool using compressed air to atomize sprayable material and apply it to a surface

   B. Bleeder gun--A spray gun designed without an air valve

   C. Nonbleeder gun--A spray gun equipped with an air valve which shuts off the air when the trigger is released

   D. External mix--A spray gun that mixes and atomizes air and material outside the air cap

   E. Internal mix--A spray gun that mixes air and material inside the cap before expelling them

   F. Suction feed--A type of spray gun in which a stream of compressed air creates a vacuum allowing atmospheric pressure to force material from an attached container to the spray head of the gun

   G. Pressure feed--A spray gun with an air cap not necessarily designed to create a vacuum

   H. Spray patterns--Type of patterns created by adjusting the fan adjustment screw

   I. Air transformer--A device which removes oil, dirt, and moisture from compressed air; filters and regulates the air; indicates by gauges regulated air pressures; and provides outlets for spray guns, dusters, and other air tools

   J. Air compressor--A machine designed to pump air from atmospheric to a higher pressure

   K. Air hose--Special hose for transferring air from the air transformer to the spray gun

      (NOTE: The size of the air hose is very important to be able to receive adequate pressure at the gun.)

   L. Single stage--A piston type compressor with one or more cylinders in which air is drawn from the atmosphere and compressed to its final pressure in a single stroke

   M. Two stage--A compressor with two or more cylinders of unequal size in which air is compressed in two separate steps

INFORMATION SHEET

N. Respirator--A mask worn over the nose and mouth to prevent the inhalation of toxic pigment particles, harmful dust, and, in some cases, vapors which may be suspended in the air during spray painting or similar operations

O. Paint booth--A compartment, room, or enclosure, generally of fireproof construction, built to confine and exhaust overspray and fumes resulting from spray painting or similar operations

II. Types of paint booths

A. Dry type

B. Air wash type

III. Functions of a drying room

A. Speeds up drying if equipped with drying equipment

B. Clears booth for next job

C. Keeps fresh, wet paint jobs isolated preventing contamination from dust and flying dirt particles

IV. Methods of force drying paint (Transparency 5)

A. Oven

B. Portable force dry units

V. Basic spray equipment for a paint shop

A. Paint gun

B. Air compressor

C. Air transformer

D. Air hose

VI. Methods used to maintain an air compressor

A. Check oil every week

B. Change oil every two months

C. Check belt tension every week

D. Clean air intake breather every week

E. Drain water from tank and check air safety valve every week

INFORMATION SHEET

VII. Causes of low air pressure

  A. Air hose inside diameter too small

  B. Clogged air lines

  C. Air transformer too small

  D. Air compressor not adequate for air usage

VIII. Conditions that contaminate air compressor lines

  A. Water in the air compressor resulting from not being drained

  B. Oil in air tank, compressor needs to be overhauled

  C. Rust formed by water condensation and not draining lines daily

IX. Operation of the air transformer (Transparency 6)--Condenses oil and moisture; regulates and strains the air; and provides outlets to which spray guns, sanders, air guns, or other equipment can be connected

X. Operation of paint gun (Transparency 7)

  A. In a suction feed gun, the stream of compressed air creates a vacuum allowing atmospheric pressure to force material from an attached container to the spray head of the gun

  B. In a pressure feed gun, the fluid is forced to the gun by air pressure from a tank or pump; the air cap is not necessarily designed to create a vacuum

XI. Principle parts of the spray gun (Transparency 8)

  A. Air nozzle or cap

  B. Fluid nozzle or tip

  C. Fluid needle valve

  D. Trigger

  E. Fluid adjustment screw

  F. Air valve

  G. Spreader adjustment valve or pattern control

  H. Gun body or handle

INFORMATION SHEET

XII. Regulation of spray pattern--Regulated by turning the spreader adjustment valve which controls the air to the horn holes in the air cap; the volume of air through the horn holes regulates the size of spray pattern from a maximum width to a narrow round pattern

XIII. Triggering the gun--Action concerning the beginning or ending of a spray stroke when the trigger is released back to first pressure (air only) before starting the next stroke

(NOTE: This prevents paint buildup at the end of each stroke which may result in runs or sags. By keeping the air pressure at a constant flow, the painter prevents air surge due to air pressure building up in the air lines.)

XIV. Degrees of thickness of sprayed paint

A. Light--Mist coat

B. Medium

C. Heavy

XV. Problems from improper handling of gun (Transparency 9)

A. Runs and sags

B. Starved or thin film

C. Orange peel

XVI. Cleaning and care of the spray gun

A. Clean immediately after using

(NOTE: If the spray gun is not cleaned, the nozzle may clog or partially clog causing the spray to split and resulting in improper spray patterns.)

B. Follow proper gun cleaning techniques recommended by the manufacturer

XVII. Coats which make up the automotive finish

A. Undercoat

B. Topcoat

XVIII. Types of finishes found on automobiles today

A. Lacquer

B. Acrylic lacquer

INFORMATION SHEET

C. Enamel

D. Acrylic enamel

E. Polyurethane

F. Water base acrylic

XIX. Metallic and non metallic topcoats--A metallic topcoat has metal flake in the paint giving it a metallic appearance; nonmetallic topcoats have no metal flake

XX. Basic ingredients of a topcoat

A. Pigment

B. Binder

C. Solvent

XXI. Procedure for identification of topcoat material

A. Wet the surface to be repaired with lacquer thinner

B. If the surface is softened and can be removed, it is lacquer

C. If the surface is not softened or wrinkles up, it is enamel

XXII. Causes of weathering

A. Chemical change through oxidation

B. Exposure to the sun and other elements

C. Type of pigment composition

XXIII. Prevention of color weathering

A. Keep vehicle garaged

B. Polish and wax finish often

C. Choose colors that have pigment compositions which are more stable

XXIV. Matching colors

(NOTE: Matching colors is mostly a matter of experience.)

A. Colors may be matched by gun technique or if necessary by tinting colors

B. If tinting is used, do not try to tint the whole can of paint at once

INFORMATION SHEET

- C. Let each tinted color dry to check match and spray a check plate before refinishing
- D. Check the color in daylight as well as artificial light

XXV. Tones that refinishers need to know for proper color matching

- A. Mass tone--Color as it appears in the can
- B. Tint tone--Shade resulting from mixing a color with a mass tone

  Example: Blue-toned white

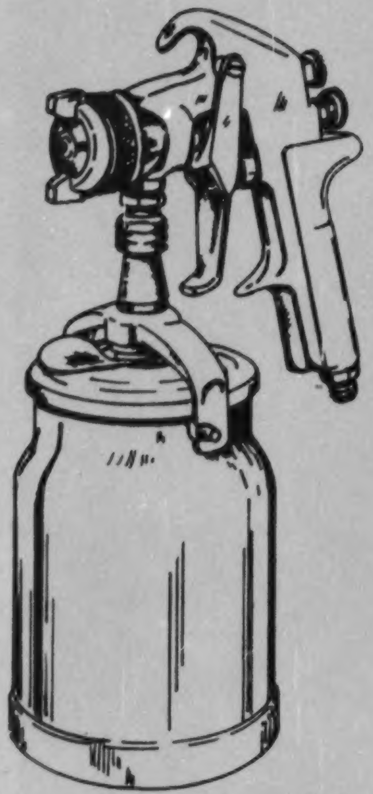
XXVI. Aids for systematic tinting

- A. Use some device for measuring
- B. Keep a supply of tinting colors
- C. Keep a record of the amount of each used

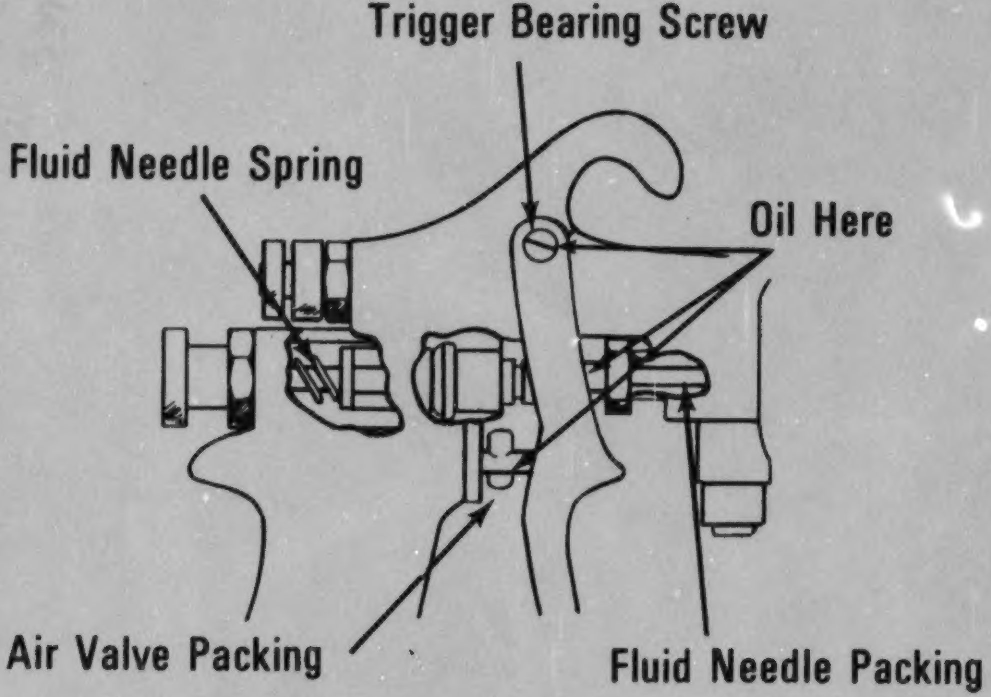
XXVII. Basic causes of poor metallic match

- A. Poor spraying technique
- B. Improper film wetness

Spray Gun and Points of Lubrication

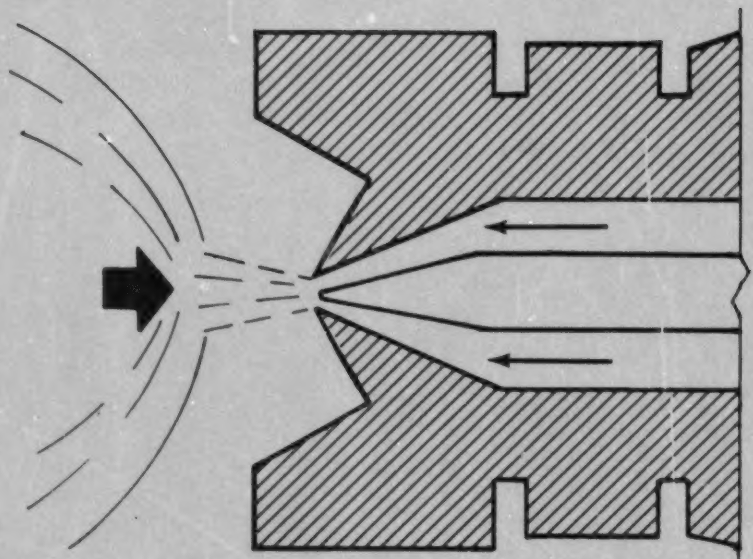


SPRAY GUN

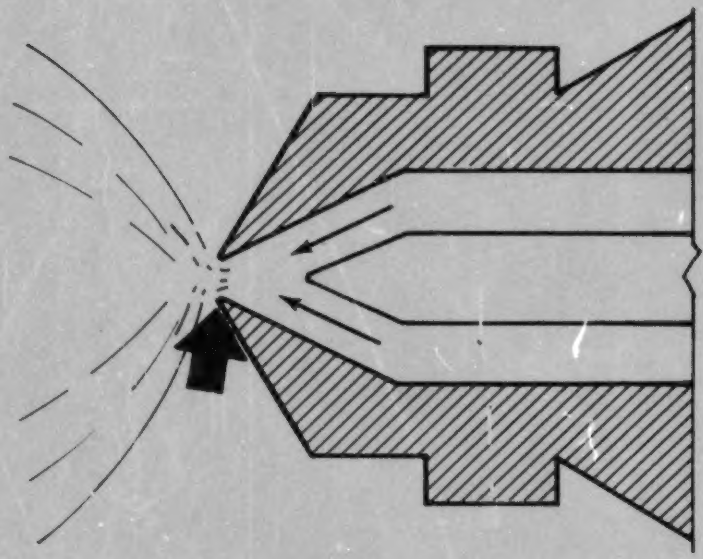

Trigger Bearing Screw
Fluid Needle Spring
Oil Here
Air Valve Packing
Fluid Needle Packing

POINTS OF LUBRICATION

Spray Gun--External Mix and Internal Mix

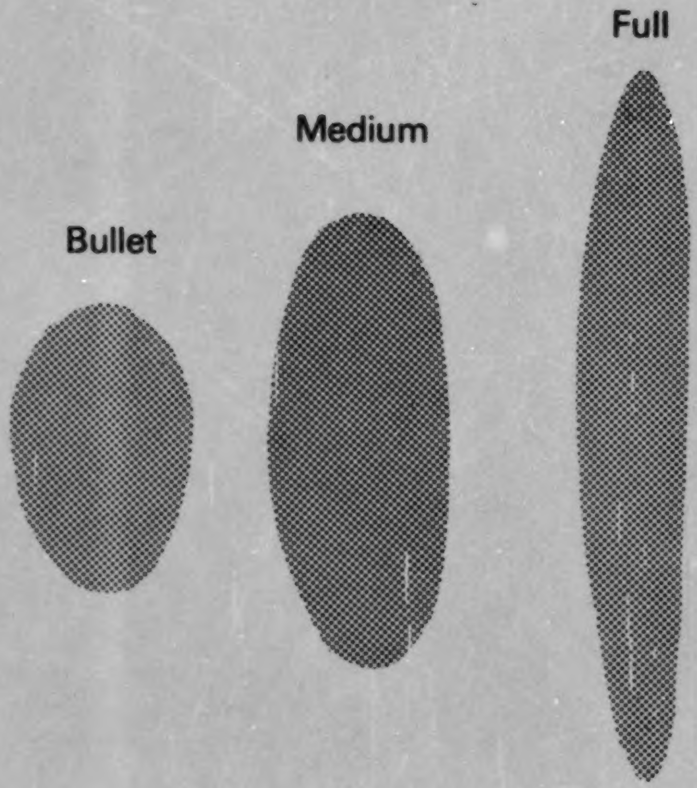


External Mix

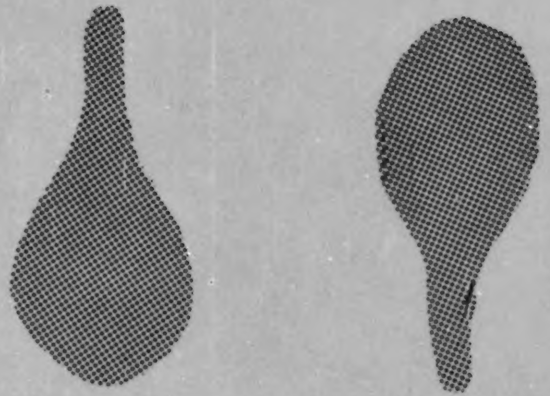


Internal Mix

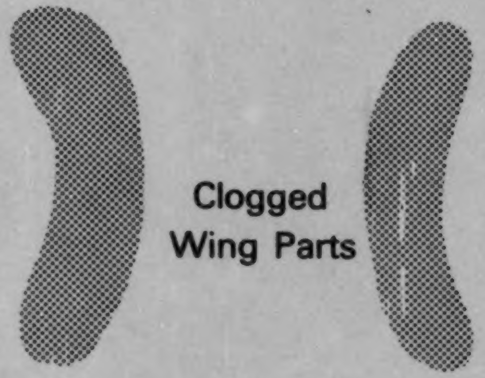
Spray Patterns


Bullet
Medium
Full

The Progression of a Fan Pattern Adjustment



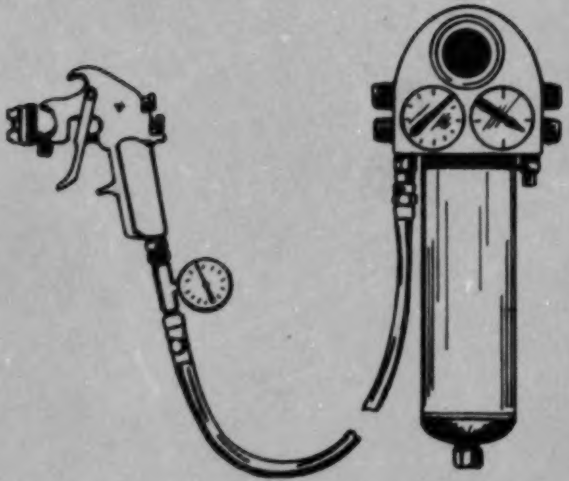
Clog at Fluid Tip on Air Cap
Material Opening, Center Orifice



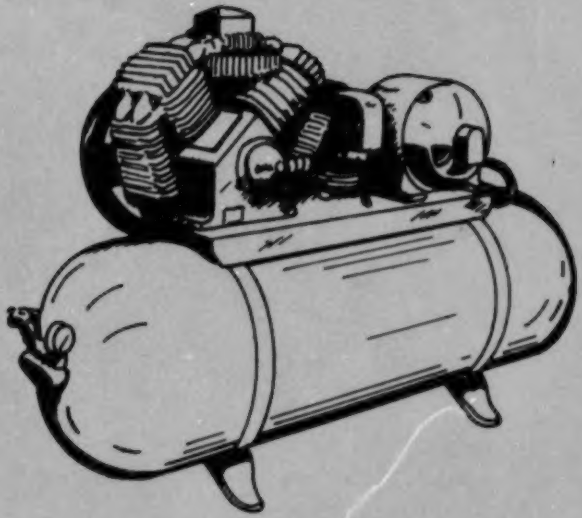
Clogged
Wing Parts

Faulty Spray Patterns

Air Transformer and Air Compressor

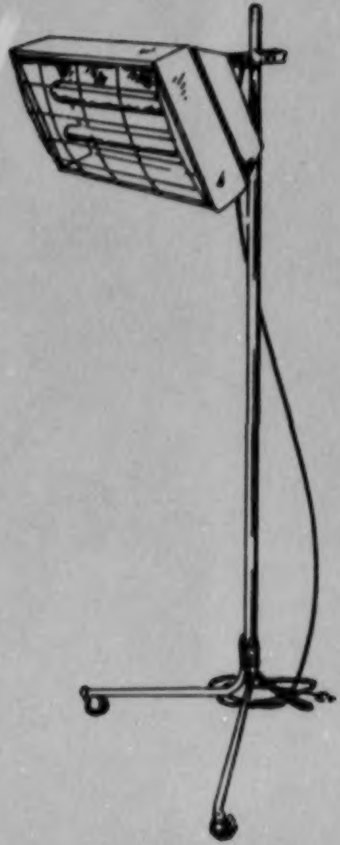


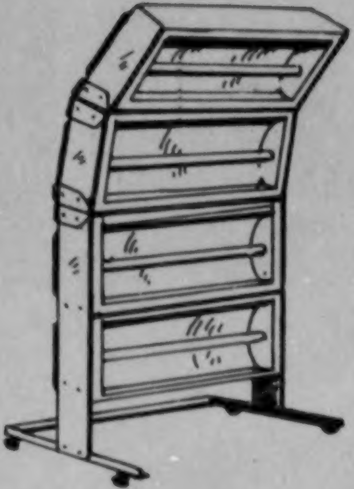
Air Transformer
and Paint Gun



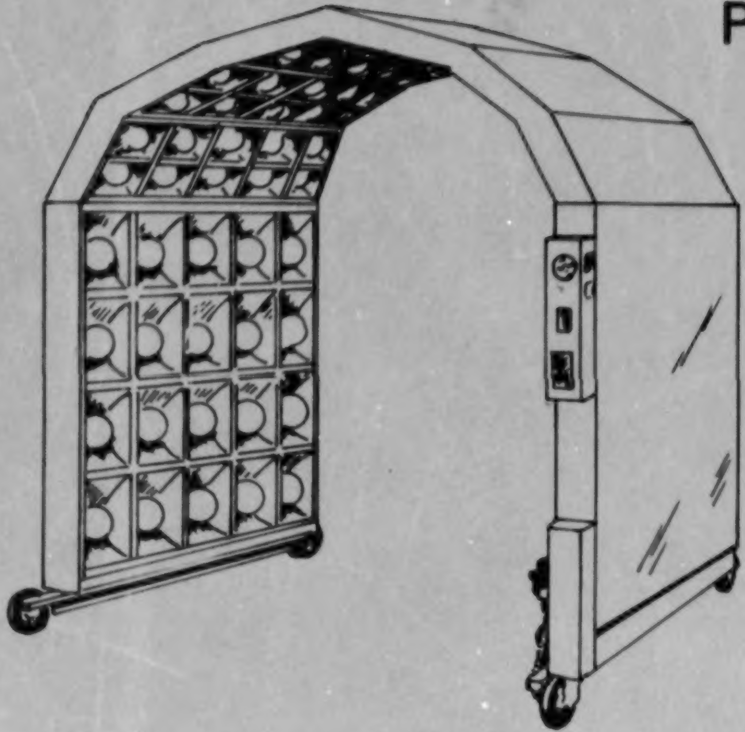
Air Compressor

Force Drying Methods



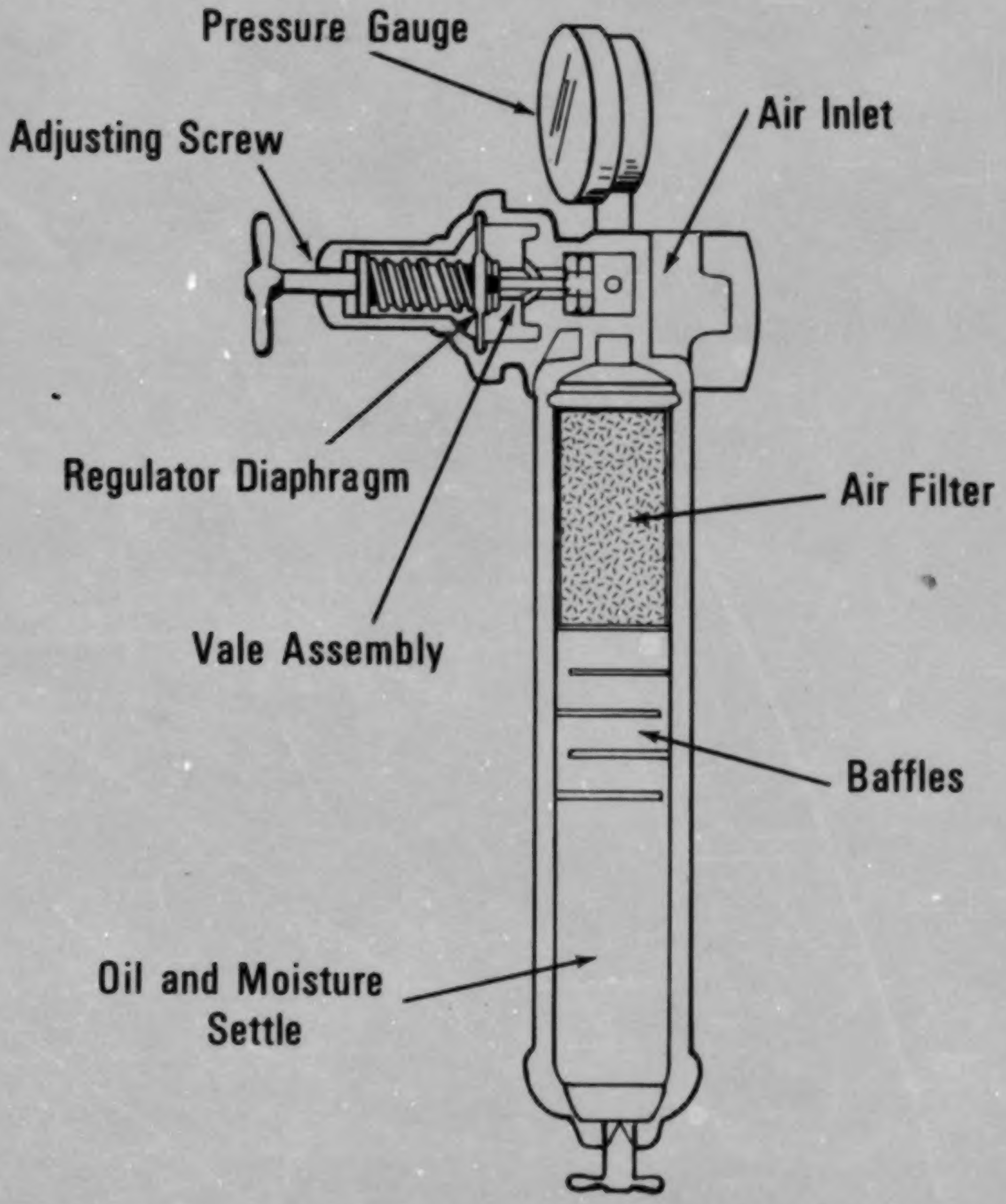


Portable Force Dry,
Infrared Units

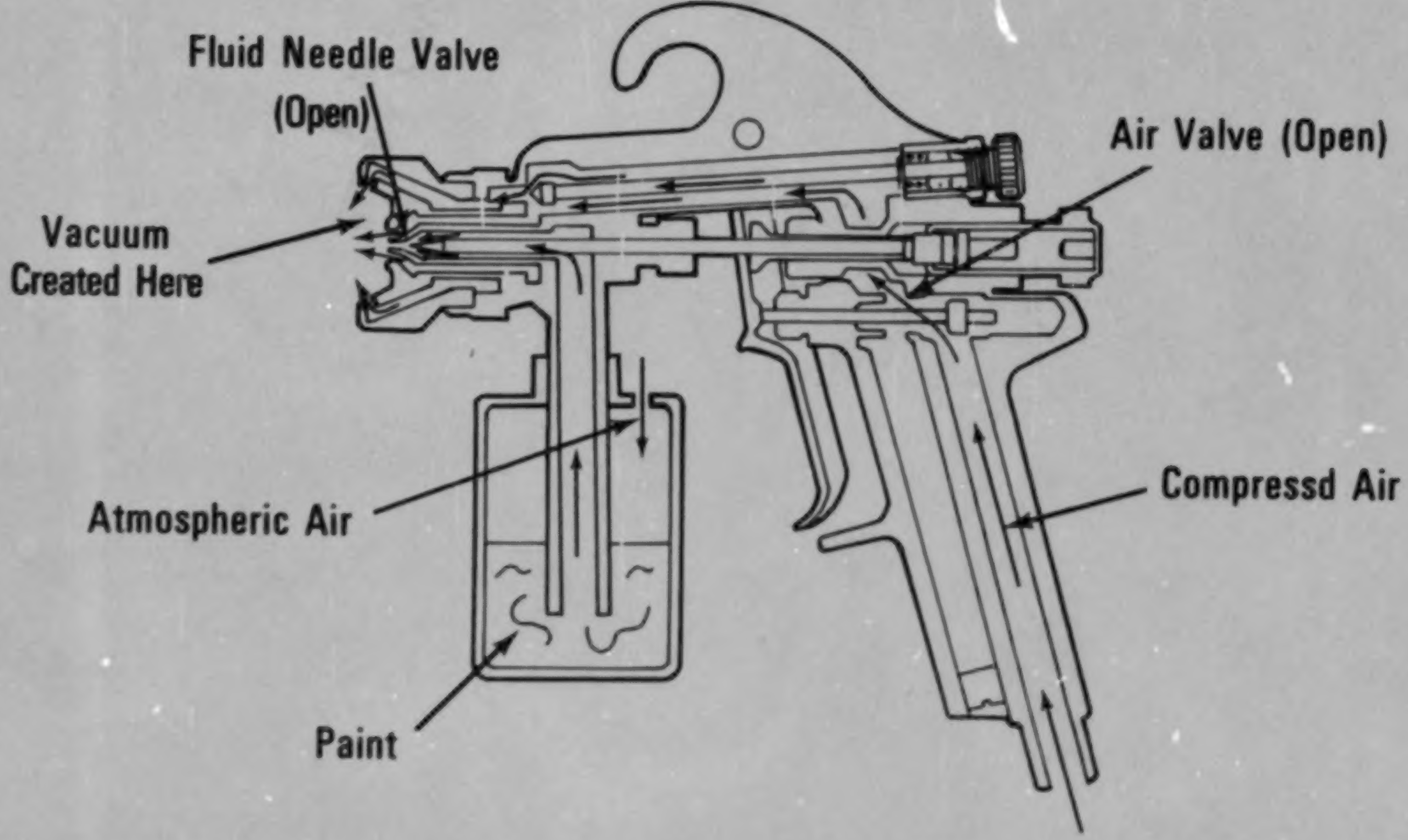


Traveling Baking Equipment

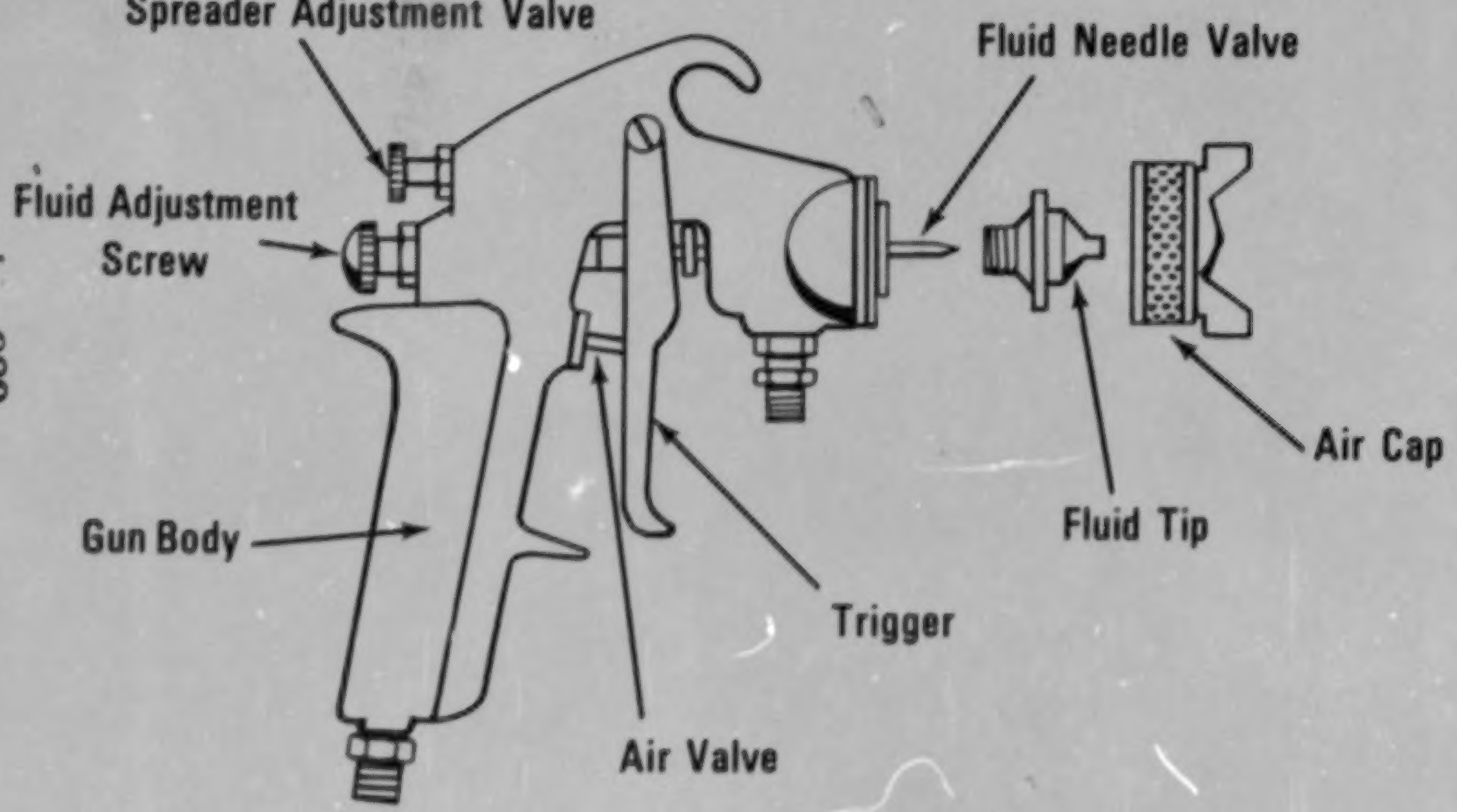
Operation of Air Transformer


Pressure Gauge
Adjusting Screw
Air Inlet
Regulator Diaphragm
Air Filter
Vale Assembly
Baffles
Oil and Moisture Settle

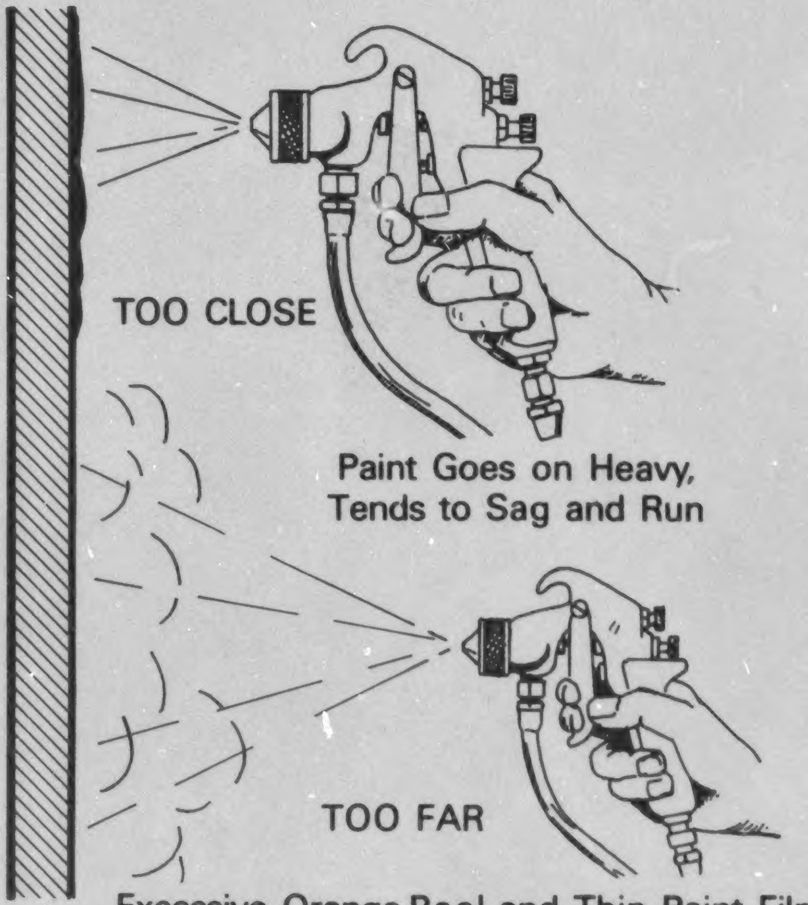
How the Suction Feed Paint Gun Works


Fluid Needle Valve
(Open)
Air Valve (Open)
Vacuum
Created Here
Atmospheric Air
Compressd Air
Paint

Principle Parts of the Spray Gun


Spreader Adjustment Valve
Fluid Needle Valve
Fluid Adjustment Screw
Air Cap
Fluid Tip
Gun Body
Trigger
Air Valve

Paint Problems from Improper Handling of Paint Gun

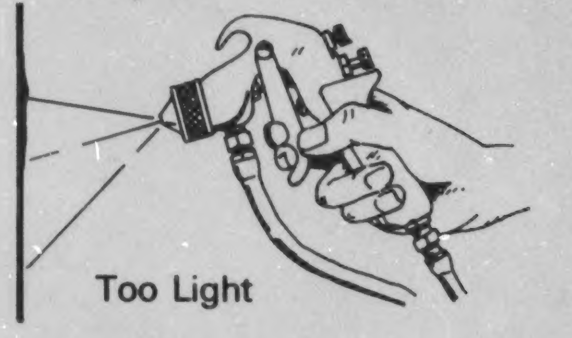


TOO CLOSE

Paint Goes on Heavy, Tends to Sag and Run

TOO FAR

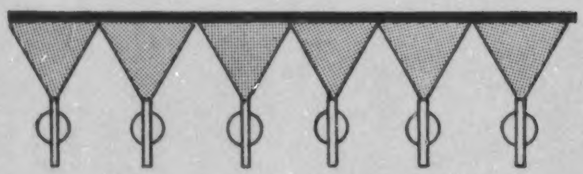
Excessive Orange Peel and Thin Paint Film



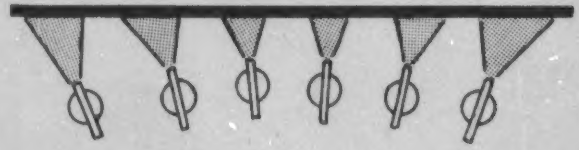
Too Heavy

TILTING THE GUN

Too Light



Keep Gun Parallel to Surface



Do Not Arc Gun

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

JOB SHEET #1--USE THE PAINT GUN WITH PROPER TECHNIQUE

I. Equipment and materials needed

- A. Spray gun
- B. Hose
- C. Air transformer
- D. Compressor
- E. Mask

II. Procedure

A. Set air pressure at the gun for the type of finish that is being sprayed (Figure 1)

(NOTE: Check directions on paint container for proper air setting and proper mixing. Pressure must be set at the gun due to air pressure loss determined by air hose size and length.)

FIGURE 1

Size of Air Hose Inside Diameter	Air Pressure Drop at Spray Gun 10-foot length	15-foot length	20-foot length	25-foot length	50-foot length
1/4-inch	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
At 40 lbs. pressure	8	9 1/2	11	12 3/4	24
At 50 lbs. pressure	10	12	14	16	28
At 60 lbs. pressure	12 1/2	14 1/2	16 3/4	19	31
At 70 lbs. pressure	14 1/2	17	19 1/2	22 1/2	34
At 80 lbs. pressure	16 1/2	19 1/2	22 1/2	25 1/2	37
At 90 lbs. pressure	18 3/4	22	25 1/4	29	39 1/2
5/16-inch					
At 40 lbs. pressure	2 3/4	3 1/4	3 1/2	4	8 1/2
At 50 lbs. pressure	3 1/2	4	4 1/2	5	10
At 60 lbs. pressure	4 1/2	5	5 1/2	6	11 1/2
At 70 lbs. pressure	5 1/4	6	6 3/4	7 1/4	13
At 80 lbs. pressure	6 1/4	7	8	8 3/4	14 1/2
At 90 lbs. pressure	7 1/2	8 1/2	9 1/2	10 1/2	16

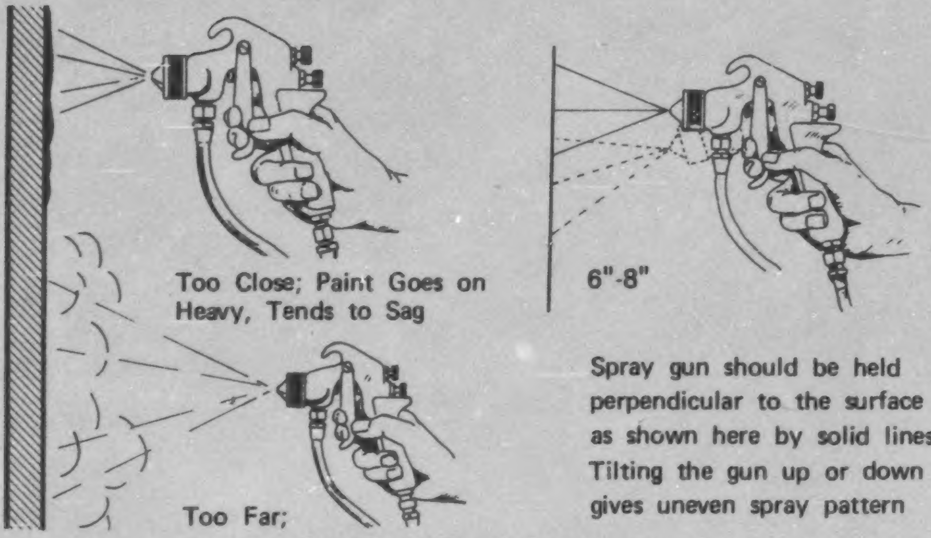
JOB SHEET #1

B. Hold gun at a proper distance from surface (Figure 2)

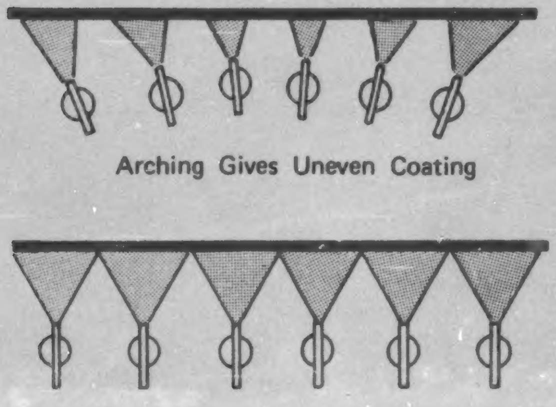
(NOTE: Every painter must find the distance which suits him best. A good rule is from 6" to 8" inches.)

(IMPORTANT: When spraying, do not arc gun.)

FIGURE 2


Too Close; Paint Goes on Heavy, Tends to Sag
6"-8"
Too Far;
Excessive Dusting, Sandy Finish

Spray gun should be held perpendicular to the surface as shown here by solid lines. Tilting the gun up or down gives uneven spray pattern


Wrong
Wrist Too Stiff
Arching Gives Uneven Coating
Right
6"-8"
Move Gun in Straight Line
Keep Wrist Flexible

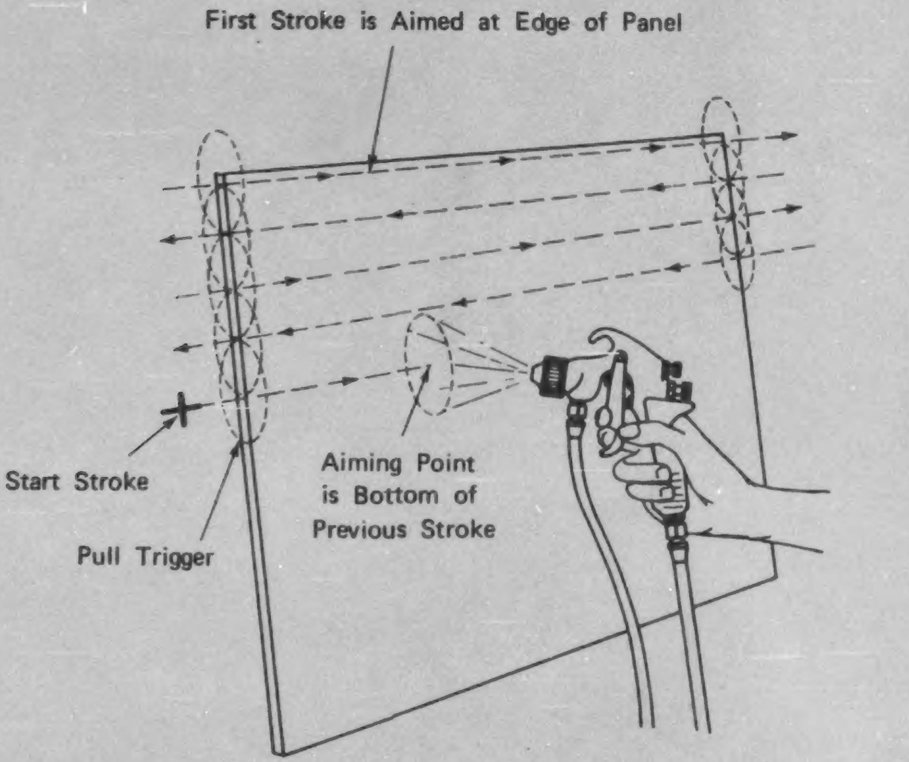
JOB SHEET #1

C. Spray panel (Figure 3)

(CAUTION: Wear approved air respirator.)

1. Aim first stroke at edge of panel
2. Start stroke at point beyond panel to be sprayed
3. Pull trigger at panel edge
4. Overlap each stroke fifty percent or one-half of the previous stroke for smooth even coverage

FIGURE 3


First Stroke is Aimed at Edge of Panel
Start Stroke
Pull Trigger
Aiming Point is Bottom of Previous Stroke

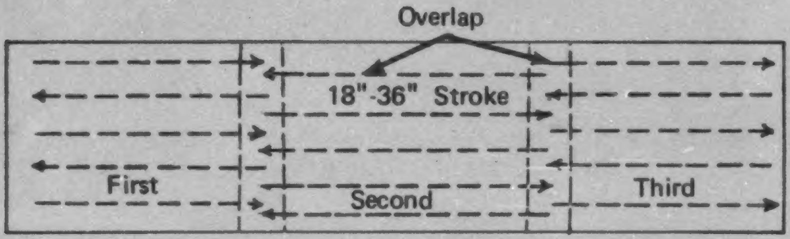
Use alternate right and left strokes, triggering gun at beginning and end of each stroke.
Pattern should overlap one-half the previous stroke.

JOB SHEET #1

5. Break up long panels into sections that are convenient to spray (Figure 4)

   (IMPORTANT: Do not lap the previous section over four inches or a sag will develop.)

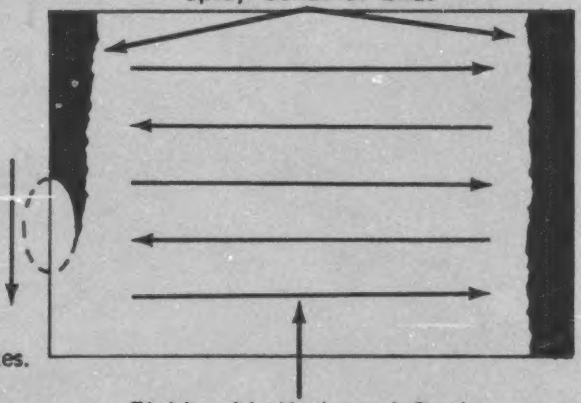
FIGURE 4



6. Band panel edges if necessary (Figure 5)

   (NOTE: This is necessary usually when there is a color change to get coverage such as in panel joints or cracks.)

FIGURE 5



Banding--Vertical bands sprayed at ends of a panel prevent overspray from horizontal strokes.

Finish with Horizontal Strokes

(IMPORTANT: The instructor should explain and give a demonstration in detail for the job sheet.)

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

JOB SHEET #2--MIX PAINT

I. Equipment and materials needed

  A. Stirring paddles

  B. Containers

  C. Strainers

  D. Paint shaker (if available)

II. Procedure

  A. Stir paint thoroughly

    1. Shake with shaker

    2. Stir with mixing paddle

    (NOTE: Always check the bottom of the can for settled pigment. All must be mixed thoroughly to have good color match.)

  B. Pour contents into another container or gun cup

    1. Wash paint can clean with a small amount of thinner or reducer

    2. Add thinner or reducer to paint

    (NOTE: This will insure that all pigment is in the paint.)

  C. Thin the paint

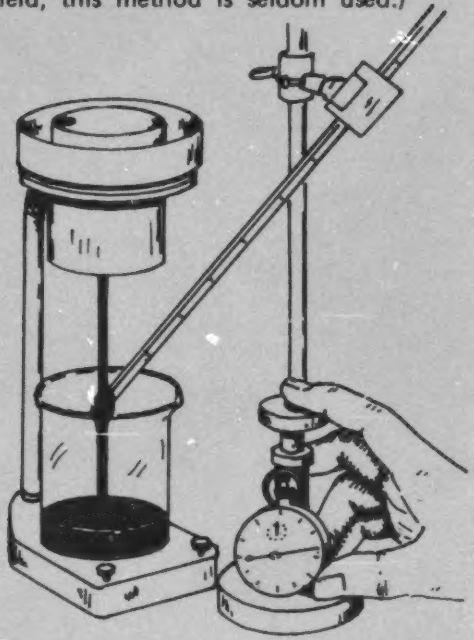
  (IMPORTANT: Always thin paint to the proper viscosity as directed by the manufacturer. Read all directions every time paint, undercoats, or sealers are used.)

JOB SHEET #2

1. Mix with viscosity cup (Figure 1)

(NOTE: In the field, this method is seldom used.)

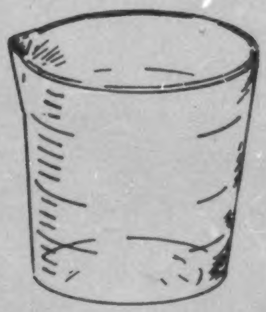
FIGURE 1



2. Mix using mixing cup (Figure 2)

(NOTE: This is suggested method for mixing paint in field.)

FIGURE 2



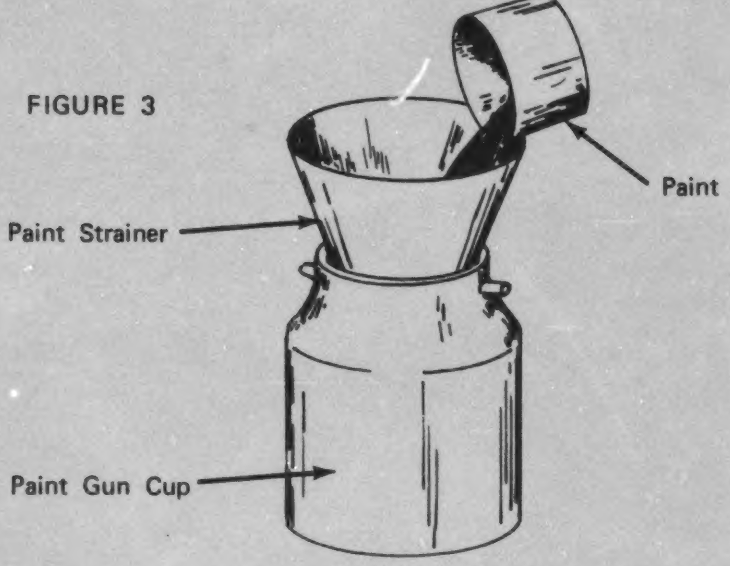
(NOTE: When adding thinner or reducer, add slowly and blend. Do not pour full amount of thinner or reducer into unthinned paint at one time.)

JOB SHEET #2

D. Pour mixed paint into gun cup

1. Strain each time paint is poured into cup (Figure 3)

FIGURE 3



2. Always place cover back on paint can after pouring to prevent unused paint from getting contaminated

E. Place paint gun cup on gun and spray

(NOTE: Never pour mixed materials back into containers containing unused materials.)

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

JOB SHEET #3--MIX AND APPLY UNDERCOATS

I. Equipment and materials needed

   A. Stirring paddles

   B. Containers

   C. Strainers

   D. Paint gun

   E. All air equipment

   F. Primers

II. Procedure

   A. Prepare the surface for primer

      1. Featheredge

      2. Backsand

      3. Clean and treat bare metal

         (NOTE: See Unit I, Sanding Painted Surfaces.)

      4. Mask as necessary

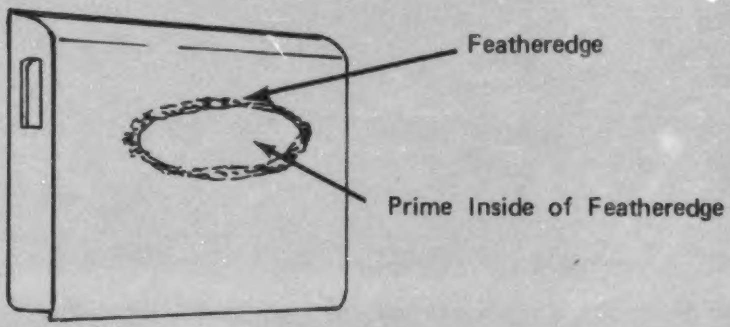
   B. Mix undercoats

      (NOTE: Refer to Job Sheet #2.)

   C. Prime metal worked area

      1. Prime first coat inside of featheredge (Figure 1)

FIGURE 1

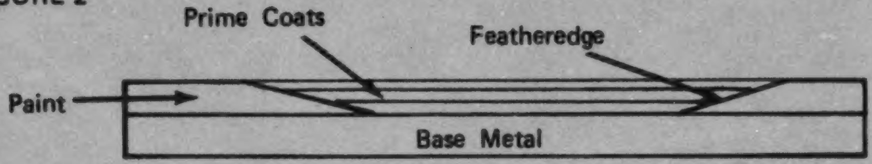


JOB SHEET #3

2. Prime a little beyond the first coat (Figure 2)

(NOTE: Each coat of primer should go beyond the preceding coat.)

FIGURE 2



(IMPORTANT: Prime repaired section until primer has built up to level of paint. Do not prime the complete panel.)

D. Prime complete body sections on automobile

1. Prepare surface according to paint manufacturer's directions

2. Prime

(NOTE: Apply primer according to directions on paint container.)

(IMPORTANT: Instructor should explain and give a demonstration for priming procedures.)

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

JOB SHEET #4–MIX AND APPLY TOPCOATS

I. Equipment and materials needed

- A. Stirring paddles
- B. Containers
- C. Strainers
- D. Paint gun
- E. Air supply equipment
- F. Paint

II. Procedure

- A. Prepare the surface

  (NOTE: See Unit I, Sanding Painted Surfaces.)

- B. Apply undercoats
- C. Mix paint

  (NOTE: Refer to Job Sheet #2.)

- D. Prepare the surface for paint
  1. Clean the surface
     - a. Blow dust out of cracks and off of surface
     - b. Wash complete car down with enamel reducer

       (NOTE: Some painters do not use enamel reducer. They use water to prevent sand scratch swelling. Always wait thirty minutes for solvent to dry from surface.)

     - c. Tack surface

       (NOTE: Always use some method of organization when washing down, tacking, and spraying such as top, right front door, right rear door, right rear fender/quarter panel, deck lid area, left rear fender/quarter panel, left rear door, left front door, right front fender, hood area, and left front fender.)

JOB SHEET #4

2. Recheck all of the automobile and areas to be sure they are correctly prepared

E. Apply topcoat (enamel)

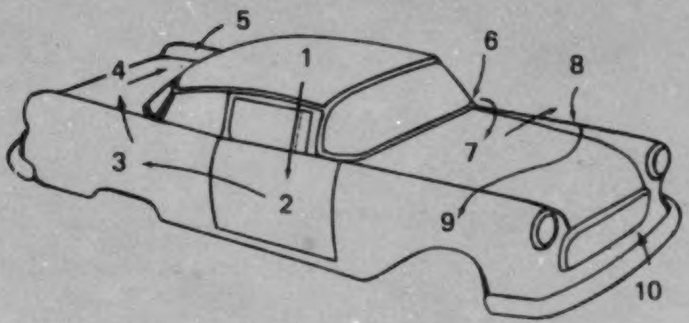
1. Apply first coat to each panel (Figure 1)

    a. Metallics--Full wet coat

    b. Solids--Medium coat

    (NOTE: If spraying an entire automobile, use the same sequence of spraying panels as used to tack them.)

FIGURE 1



One Method of Spraying a Complete Automobile

2. Allow first coat to set up

    (IMPORTANT: When spraying paint, allow each coat to flow out and become tacky before applying the second. If a painter does not wait, he will have sag and run complications.)

3. Apply second coat

    a. Metallics--Medium to light

    b. Solids--Full second coat

4. Apply third coats--Metallics only

    (IMPORTANT: Due to metallic conditions of streaking, dapling, or other characteristics, metallics may need a third fog or mist coat. Apply over entire automobile at gun distance from twelve to eighteen inches at air pressure of 60 to 70 psi at the spray gun.)

JOB SHEET #4

F. Apply topcoat (lacquer)

(NOTE: See Figure 1.)

1. Apply first coat--Each coat is a double coat
2. Apply second, third, and fourth wet double coats

   (NOTE: Allow each coat to flash (grow dull) before applying succeeding coats.)
3. Allow to dry
   - a. Overnight if air drying
   - b. Four hours if force drying
4. Compound

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

JOB SHEET #5–PERFORM A SPOT REPAIR

I. Equipment and materials needed

   A. Spray gun

   B. Spraying equipment

   C. Mask or respirator

   D. Rubbing compound

   E. Towels

II. Procedure

   A. Prepare the surface for primer

   (NOTE: See Unit I, Sanding Painted Surfaces.)

   B. Apply undercoats

   C. Prepare the surface for spot repair

   D. Mix paint

   (NOTE: Refer to Job Sheet #2.)

   E. Prepare the surface for paint

      1. Clean the surface

         a. Blow dust out of cracks and off of surface

         b. Wash complete panel with enamel reducer

         (NOTE: Some painters prefer to use water at this point.)

         c. Tack surface

      2. Recheck all of the panels to be spotted to be sure they are correctly prepared

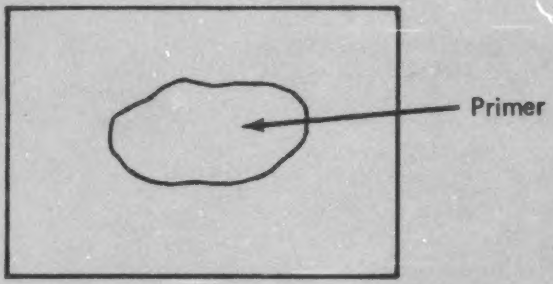
JOB SHEET #5

F. Apply paint

1. Paint first coat over primer (Figure 1)

   (CAUTION: Wear your respirator.)

FIGURE 1



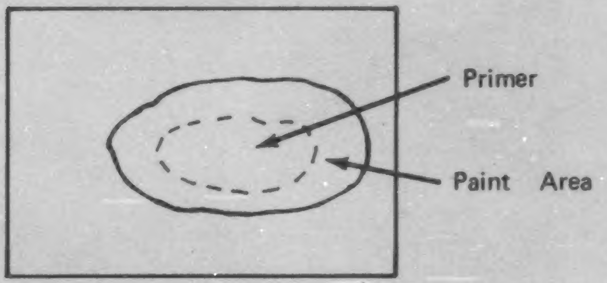
   a. Allow to flash

   b. Apply second coat over primer

      (NOTE: Cover all primed spots until color is uniform and no primer bleeds through. Always tack between coats.)

2. Apply coat over entire area to be spotted (Allow to flash) (Figure 2)

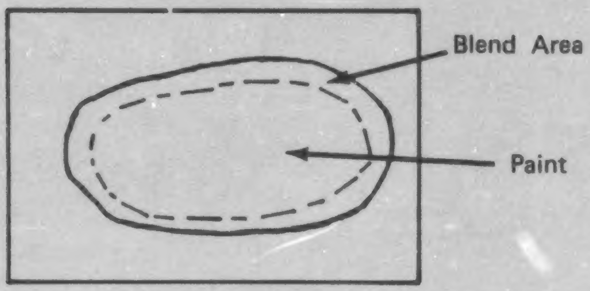
FIGURE 2



JOB SHEET #5

3. Apply second coat just beyond first coat (Allow to flash)
4. Add thinner, according to directions by paint manufacturer as stated on the can
5. Blend in paint edge (Figure 3)

FIGURE 3



6. Allow to dry
   a. Four hours if force drying
   b. Overnight if air drying
7. Compound

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

JOB SHEET #6--PERFORM A PANEL REPAIR

I. Equipment and materials needed

   A. Spray gun

   B. Spraying equipment

   C. Mask or respirator

   D. Rubbing compound

   E. Towels

II. Procedure

   A. Prepare the surface for primer

   (NOTE: See Unit I, Sanding Painted Surfaces.)

   B. Apply undercoat

   C. Prepare the surface for panel repair

   D. Mix paint

   E. Prepare the surface for paint by cleaning it

      1. Blow dust out of cracks and off of surface

      2. Wash complete panel down with enamel reducer

      (NOTE: Some painters prefer to use water at this point.)

      3. Tack

   F. Apply paint

      1. Lacquer

         a. Spray all primer spots

         (NOTE: Apply necessary coats on spots to where primer does not bleed through.)

         b. Spray one coat over entire panel (Allow to flash)

JOB SHEET #6

- c. Spray two to three more wet coats over panel allowing each to flash
- d. Let dry
    - 1) Four hours if forced drying
    - 2) Overnight if air drying
- e. Compound

2. Enamel
    - a. Spray first coat
        - 1) Medium if solid color
        - 2) Full if metallic color
    - b. Spray second coat
        - 1) Full if solid color
        - 2) Medium to light if metallic color
    - c. Let dry

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

JOB SHEET #7--MATCH COLORS

I. Equipment and materials needed

  A. Spray gun

  B. Tinting colors

II. Procedure

  A. Spray a test card

    1. Spray over light gray primer card

    2. Spray over dark gray primer card

    3. Spray over red oxide primer card

  B. Check against color on vehicle and choose closest match

  C. Try spray gun techniques

    1. Spray wet

    2. Spray dry

    3. Increase gun pressure

    4. Decrease gun pressure

    5. Increase gun distance

    6. Decrease gun distance

    (NOTE: Above procedure will lighten or darken colors.)

  D. Check match against color on vehicle and choose closest match

  E. Tint color

    1. Use only a small amount of paint

    2. Add only drops of tinting color at a time

    3. Spray on test card and compare to automobile

      a. Check in daylight

      b. Check in artificial (shop) light

JOB SHEET #7

4. Use tinting chart to choose solution to get the necessary match (Figure 1)

FIGURE 1

COLOR	IF COLOR TOO STRONG ADD	IF COLOR TOO LIGHT ADD	IF COLOR TOO GREEN ADD	IF COLOR TOO RED ADD	IF COLOR TOO YELLOW ADD	IF COLOR TOO BLUE ADD	IF COLOR TOO "DIRTY" ADD
Gray	White	Black	Mix White and Oxide Red	Medium Green	Mix White and touch of Indo Blue	Mix Med. Yellow and either Cadmium Red or Oxide Red	Mix White and either Blue Toner or Indo Blue
Blue	White	Blue or Blue Toner or Indo Blue	Deep Maroon	Medium Green	Deep Maroon	Mix Med. Yellow and either Cadmium Red or Oxide Red	Mix White and Blue Toner
Green	White or Yellow	Medium Green or Blue or Blue Toner		Mix Blue Toner and Med. Yellow and Medium Green	Blue Toner	Mix Med. Yellow and either Cadmium Red or Oxide Red	Mix Med. Yellow and Blue Toner
Red	Mix White and Cadmium Red	Oxide Red or Light Maroon			Light Maroon	Oxide Red	Mix Light Maroon and Touch of White
Maroon	Light Maroon or Cadmium Red	Deep Maroon			Deep Maroon	Light Maroon or Oxide Red or Medium Yellow	Mix Deep Maroon and Touch of White
Yellow	White or Medium Yellow	Ferrite Yellow or Medium Yellow	Mix White and touch of Cadmium Red	Mix White and Light Green	White		Mix White and Medium Yellow
Orange	Medium Yellow	Cadmium Red or Orange	Mix Cadmium Red and Medium Yellow	Medium Yellow	Cadmium Red or Toluidine Red		Mix Med. Yellow and either Cadmium Red or Toluidine Red
Ivory	White	Ferrite Yellow or Medium Yellow	Orange or touch of Cadmium Red	Mix White and Light Green	White		Mix White and touch of either Ferrite Yellow or Medium Yellow
Brown	Mix White and either Orange or Burnt Sienna	Mix Black and Medium Yellow and Oxide Red	Oxide Red or Burnt Sienna	Mix Light Green and Burnt Sienna (Add White if Necessary)	Mix Oxide Red and Black		Mix Ferrite Yellow and Oxide Red and touch of either Orange or Burnt Sienna
Cream	White	Ferrite Yellow or Medium Yellow	Mix White and either Orange or Cadmium Red	Mix Medium Yellow and White (Add Light Green if Necessary)	White		Mix White and touch of either Ferrite Yellow or Medium Yellow
Tan	White	Burnt Sienna or Mix Ferrite Yellow and Black	Cadmium Red or Toluidine Red (Add White if Necessary)	Mix White and Touch of Light Green	Mix White and Either Cadmium Red or Toluidine Red		Mix White and either Oxide Red or Ferrite Yellow

GLAMOUR COLOR	IF COLOR TOO GREEN ADD	IF COLOR TOO BLUE ADD	IF COLOR TOO "DIRTY" ADD
Blue	Indo Blue or Deep Maroon	Green Toner	Blue Toner and touch of White
Green	Blue Toner	Old Gold	Touch of White
Brown	Burnt Sienna and Light Maroon	Old Gold or Burnt Sienna	Burnt Sienna or Old Gold
Maroon		Burnt Sienna or Light Maroon	Cadmium Red

CAUTION: A few drops of shading color may be enough, especially when the fresh color is too yellow, blue, green or red. Occasionally, two shading steps are needed for an accurate match. Glamour colors are very sensitive. Be very careful toning colors with these bases: Old Gold Toner, Blue Toner, Green Toner, Indo Blue.

If the color contains not more than 20 parts of the glamour color base, use the regular tinting instructions. If the color contains more than 20 parts of the glamour color base, follow the instructions in the small chart.

If necessary, add polychrome base, a very small amount at a time, to maintain brilliance.

5. Spray panel or spot as necessary

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

TEST

1. Match the following terms with the correct definition.

_____a. A device which removes oil, dirt, and moisture from compressed air; filters and regulates the air; indicates by gauges regulated air pressures; and provides outlets for spray guns, dusters, and other air tools

_____b. A mask worn over the nose and mouth to prevent the inhalation of toxic pigment particles, harmful dust, and, in some cases, vapors which may be suspended in the air during spray painting or similar operations

_____c. Type of patterns created by adjusting the fan adjustment screw

_____d. A compartment, room, or enclosure, generally of fireproof construction, built to confine and exhaust overspray and fumes resulting from spray painting or similar operations

_____e. A machine designed to pump air from atmospheric to a higher pressure

_____f. A compressor with two or more cylinders of unequal size in which air is compressed in two separate steps

_____g. A piston type compressor with one or more cylinders in which air is drawn from the atmosphere and compressed to its final pressure in a single stroke

1. Spray gun
2. Bleeder gun
3. Nonbleeder gun
4. External mix
5. Internal mix
6. Suction feed
7. Pressure feed
8. Spray patterns
9. Air transformer
10. Air compressor
11. Air hose
12. Single stage
13. Two stage
14. Respirator
15. Paint booth

______h. A spray gun that mixes and atomizes air and material outside the air cap

______i. Special hose for transferring air from the air transformer to the spray gun

______j. A spray gun with an air cap not necessarily designed to create a vacuum

______k. A spray gun designed without an air valve

______l. A spray gun equipped with an air valve which shuts off the air when the trigger is released

______m. A type of spray gun in which a stream of compressed air creates a vacuum allowing atmospheric pressure to force material from an attached container to the spray head of the gun

______n. A tool using compressed air to atomize sprayable material and apply it to a surface

______o. A spray gun that mixes air and material inside the cap before expelling them

2. Name the two types of paint booths.

a.

b.

3. List the three functions of a drying room.

   a.

   b.

   c.

4. Name two methods for force drying paint.

   a.

   b.

5. Name the four items of basic spray equipment that would be adequate for a paint shop.

   a.

   b.

   c.

   d.

6. Write the five methods used to maintain an air compressor.

   a.

   b.

   c.

   d.

   e.

7. List four causes of low air pressure.

   a.

   b.

   c.

   d.

8. List three conditions that contaminate air compressor lines.

   a.

   b.

   c.

9. Describe the operation of the air transformer.

10. Describe how the paint gun works.

11. Identify the principal parts of the spray gun.

a.

b.

c.

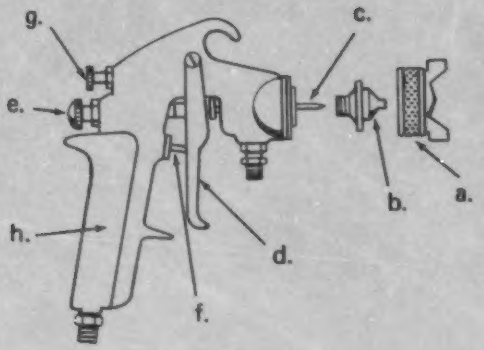
d.

e.

f.

g.

h.



12. Describe how to regulate the spray pattern.

13. Describe triggering the gun.

14. List the three degrees of thickness of sprayed paint.

a.

b.

c.

15. Name three problems that can happen when the gun is handled improperly.

    a.

    b.

    c.

16. Describe cleaning and care of the spray gun.

17. Name the two coats that make up the automotive finish.

    a.

    b.

18. List six types of finishes found on automobiles today.

    a.

    b.

    c.

    d.

    e.

    f.

19. Describe how to distinguish between a metallic topcoat and a non-metallic topcoat.

20. Name the three basic ingredients of a topcoat.

    a.

    b.

    c.

21. Describe the procedure used to identify whether a topcoat is lacquer or enamel.

    a.

    b.

    c.

22. List three causes of color weathering.

    a.

    b.

    c.

23. List three ways to prevent color weathering.

    a.

    b.

    c.

24. Describe the procedure for matching colors.

25. Name the two tones that refinishers need to know for proper color matching.

    a.

    b.

26. List three aids for systematic tinting.

    a.

    b.

    c.

27. Name two basic causes of poor metallic match.

    a.

    b.

28. Demonstrate the ability to:

    a. Use the paint gun with proper technique.

    b. Mix paint.

    c. Mix and apply undercoats.

    d. Mix and apply topcoats.

    e. Perform a spot repair.

    f. Perform a panel repair.

g. Match colors.

(NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

SPRAYING AUTOMOTIVE FINISHES
UNIT IV

ANSWERS TO TEST

1. a. 9
   b. 14
   c. 8
   d. 15
   e. 10
   f. 13
   g. 12
   h. 4
   i. 11
   j. 7
   k. 2
   l. 3
   m. 6
   n. 1
   o. 5
2. a. Dry type
   b. Air wash type
3. a. Speeds up drying if equipped with drying equipment
   b. Clears booth for next job
   c. Keeps fresh, wet paint jobs isolated preventing contamination from dust and flying dirt particles
4. a. Oven
   b. Portable force dry units

5. a. Paint gun
   b. Air compressor
   c. Air transformer
   d. Air hose
6. a. Check oil every week
   b. Change oil every two months
   c. Check belt tension every week
   d. Clean air intake breather every week
   e. Drain water from tank and check air safety valve every week
7. a. Air hose inside diameter too small
   b. Clogged air lines
   c. Air transformer too small
   d. Air compressor not adequate for air usage
8. a. Water in the air compressor resulting from not being drained
   b. Oil in air tank, compressor needs to be overhauled
   c. Rust formed by water condensation and not draining lines daily
9. The air transformer condenses oil, and moisture; regulates and strains the air; and provides outlets to which spray guns, sanders, air guns, or other equipment can be connected
10. Description should include:
    a. In a suction feed gun, the stream of compressed air creates a vacuum allowing atmospheric pressure to force material from an attached container to the spray head of the gun
    b. In a pressure feed gun, the fluid is forced to the gun by air pressure from a tank or pump; the air cap is not necessarily designed to create a vacuum
11. a. Air nozzle or cap
    b. Fluid nozzle or tip
    c. Fluid needle valve
    d. Trigger
    e. Fluid adjustment screw
    f. Air valve

g. Spreader adjustment valve or pattern control

h. Gun body or handle

12. The spray pattern is regulated by turning the spreader adjustment valve which controls the air to the horn holes in the air cap; the volume of air through the horn holes regulates the size of spray pattern from a maximum width to a narrow round pattern

13. Triggering the gun is the action concerning the beginning or ending of a spray stroke when the trigger is released back to first pressure (air only) before starting the next stroke

14. a. Light--Mist coat

    b. Medium

    c. Heavy

15. a. Runs and sags

    b. Starved or thin film

    c. Orange peel

16. Description should include:

    a. Clean immediately after using

    b. Follow proper gun cleaning techniques recommended by the manufacturer

17. a. Undercoat

    b. Topcoat

18. a. Lacquer

    b. Acrylic lacquer

    c Enamel

    d. Acrylic enamel

    e. Polyurethane

    f. Water base acrylic

19. A metallic topcoat has metal flake in the paint giving it a metallic appearance; nonmetallic topcoats have no metal flake

20. a. Pigment

    b. Binder

    c. Solvent

21. Description should include:
    a. Wet the surface to be repaired with lacquer thinner
    b. If the surface is softened and can be removed, it is lacquer
    c. If the surface is not softened or wrinkles up, it is enamel
22. a. Chemical change through oxidation
    b. Exposure to the sun and other elements
    c. Type of pigment composition
23. a. Keep vehicle garaged
    b. Polish and wax finish often
    c. Choose colors that have pigment compositions which are more stable
24. Description should include:
    a. Colors may be matched by gun technique or if necessary by tinting colors
    b. If tinting is used, do not try to tint the whole can of paint at once
    c. Let each tinted color dry to check match and spray a check plate before refinishing
    d. Check the color in daylight as well as artificial light
25. a. Mass tone
    b. Tint tone
26. a. Use some device for measuring
    b. Keep a supply of tinting colors
    c. Keep a record of the amount of each used
27. a. Poor spraying technique
    b. Improper film wetness
28. Performance skills will be evaluated according to the criteria listed on the progress chart.

DETAILING
UNIT V

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with detailing and describe the procedures for the detail operations. He should be able to compound, polish, remove overspray, and detail spot repair, panel repair, or complete paint jobs. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with detailing to a list of definitions.
2. Describe the hand compounding method.
3. Name the areas where a polishing buffer cannot be used.
4. Choose from a list of hand rubbing compounds the one that would be used for compounding enamel finishes.
5. Name the liquid that is used to remove paint overspray from moldings and glass.
6. Describe the effect that lacquer thinner has on fresh enamel.
7. Demonstrate the ability to:
    a. Compound, polish, and detail a spot or panel repair.
    b. Compound, polish, and detail a complete lacquer paint job.
    c. Detail a complete enamel paint job.
    d. Detail a complete enamel paint job on a commercial truck.

DETAILING
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Discuss terminal and specific objectives.

  D. Discuss information sheet.

  E. Demonstrate and discuss procedures outlined in job sheets.

  F. Give test.

II. Students:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Job sheets

    1. Job Sheet #1--Compound, Polish, and Detail a Spot or Panel Repair

    2. Job Sheet #2--Compound, Polish, and Detail a Complete Lacquer Paint Job

    3. Job Sheet #3--Detail a Complete Enamel Paint Job

    4. Job Sheet #4--Detail a Complete Enamel Paint Job on a Commercial Truck

   D. Test

   E. Answers to test

II. References:

   A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* Fi First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Co., 1969.

   B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

   C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

   D. Spicer, Edward D. *Automotive Collision Works.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

   E. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

   F. *Automotive Refinishing Manual S-ARMF (385) JPI.* St Paul, Minnesota: 3M Minnesota Mining and Manufacturing Co.

   G. *Motor Crash Estimating Guide.* March 1970, vol. 2. no. 3. New York: The Harst Corp.

   H. *Ford Autolite Body and Collision Parts Catalog.* AF-7832-72, 1972 Edition.

   I. Tait, A., A. G. Deroche, and N. N. Hildebrand. *The Principles of Auto Body Repairing and Repainting.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

DETAILING
UNIT V

INFORMATION SHEET

I. Terms and definitions

   A. Detailing--The clean up and get ready operation during spot, panel, or all over refinishing

   B. Rubbing compound--Fine abrasive material in a creamy consistency used either by hand or for machine polishing

   (NOTE: It is used to remove dirt nibs, overspray dust, and orange peel from lacquer and enamel surfaces. It is also used to remove road film and oxidation from the blend in area before spot repair.)

   C. Dirt nibs--Small specks of foreign material in a dried paint film

   D. Luster--Gloss or sheen or brightness of a finish

   E. Orange peel--Term used to describe an uneven pebbly surface resembling the skin of an orange; appears in a paint film that has been applied by spray

   F. Overspray--Unwanted, extra paint spray on the surface of chrome, glass, or adjacent panels

II. Hand compounding method

   A. Make a ball out of a soft cloth

   B. Place a small amount of rubbing compound on ball of cloth

   C. Rub surface to be compounded with a back and forth motion until rubbing compound is worn off of the surface

   D. Repeat steps B and C until desired luster is achieved

   E. Wipe surface with a clean dry cloth

III. Areas where a polishing buffer cannot be used

   A. Around windows

   B. Around chrome moldings, trim, emblems

   C. Around windshield wipers

   D. On any extruding body panel crease or edge

INFORMATION SHEET

IV. Compound used for enamel finishes--Synthetic or extra fine rubbing compound

V. Liquid used to remove overspray-Lacquer thinner

VI. Effect lacquer thinner has on fresh enamel--It will wrinkle the finish and the finish will be removed if allowed to come into contact with the thinner

DETAILING
UNIT V

JOB SHEET #1--COMPOUND, POLISH, AND DETAIL A SPOT OR PANEL REPAIR

I. Equipment and materials needed

   A. Buffer/polisher

   B. Bonnet

   C. Shop towels

   D. Soft polishing cloth

   E. Lacquer thinner

   F. Polish

   G. Compounds

   H. Hand tool set

II. Procedure

   A. Remove masking from panel

   B. Compound paint

      1. If paint has too much orange peel, sand lightly with 600 grit or a finer paper until texture matches that of adjacent panels

         (IMPORTANT: In case of a spot repair, be sure you do not sand through the blend area. Sand only where full coats have been applied.)

      2. Compound paint until proper luster is acquired using the hand application method

         a. Apply a small amount of compound to a rubbing ball made of a clean soft cloth

         b. Rub finish in back-and-forth motions until the desired smoothness is obtained

            (NOTE: Rubbing compound must be worn off the surface. It is an abrasive and cuts the paint to smooth it. You do not apply to the surface, let dry, and wipe off.)

JOB SHEET #1

c. Apply polish

    1) Apply evenly over entire surface

    2) Wipe off surface when dry with soft cloth

3. Compound paint until proper luster is acquired using the machine application method

    a. Apply compound to surface

    (NOTE: Use a cream type compound. This can be made by thinning hand rubbing compound with clean water.)

    b. Polish the panel using same techniques used with a grinder; that is, apply equal pressure and a crosscutting or buffing motion

    (IMPORTANT: Keep polisher moving until rotation stops. If you stop the polisher or allow it to stop on the surface, the paint will overheat and burn.)

    c. Apply polish

        1) Apply evenly over entire surface

        2) Wipe off surface when dry with a clean soft cloth

        (NOTE: Special polishes are made to use with power polishes to fill buffer swirl marks.)

    d. Install all parts removed to make repair

        1) Chrome moldings

        2) Emblems

        3) Trim

        (NOTE: Always clean and polish parts before they are installed.)

    e. Detail panels

        1) Clean dirt and compound from door jams, under the hood, and under the deck lid

        2) Clean dirt and compound from cracks, body joints, and adjacent panels

JOB SHEET #1

3) Touch up paint

(NOTE: See your instructor to find out how to touch up chips, scratches, door knocks, or other damage.)

DETAILING
UNIT V

JOB SHEET #2--COMPOUND, POLISH, AND DETAIL A COMPLETE LACQUER PAINT JOB

I. Equipment and materials needed

   A. Buffer

   B. Bonnet

   C. Shop towels

   D. Soft cloth

   E. Lacquer thinner

   F. Polish

   G. Compounds

   H. Tire black

II. Procedure

   A. Remove masking from vehicle

   B. Sand finish with 600 or finer paper

      1. Wet sand entire vehicle

         (IMPORTANT: Sand only by hand. Do not use a sanding block or pad. Do not sand edges, creases in panel, or other similar areas. See your instructor.)

      2. Wash off all sanding residue

         (NOTE: Sanding of the lacquer finish will remove all orange peel from the paint. Be sure that sanding is done properly and that enough paint has been applied to allow for sanding.)

   C. Compound

      1. Machine compound

         a. Top panel

         b. Hood panels

JOB SHEET #2

        c. Deck lid panels

        d. Right side

        e. Left side

    2. Hand compound

        a. Around windows

        b. Bumpers

        c. Small panels that are not accessible with the machine

        (NOTE: Rubbing compound is an abrasive and must be worn off the surface to acquire the proper luster. Do not apply, let dry, and wipe off.)

        (IMPORTANT: Keep polisher moving until rotation stops. If you stop the polisher or allow it to stop on the surface, the paint will overheat and burn.)

D. Wash vehicle

E. Polish all chrome parts before installing

F. Remove overspray and polish

    1. Chrome moldings and bumpers

    2. Trim

    3. Emblems

    (NOTE: Watch for metal or plastic moldings and trim with painted inserts as lacquer thinner may remove the paint from the moldings. Plastic moldings may also be damaged.)

G. Vacuum, dust, and polish painted surfaces

    1. Interior

    2. Trunk interior

H. Clean under hood

I. Wash tires and wheel covers

(NOTE: Paint wheels and rubber tires if necessary. Use only rubber tire black paint for tires.)

JOB SHEET #2

J. Polish vehicle

   1. Apply evenly over entire surface

   2. Wipe off surface when dry with a clean soft cloth

      (NOTE: Special polishes are made to use with power polishers to fill swirl marks.)

   3. Clean polish from

      a. Cracks

      b. Body joints

      c. Louvers

      d. Around moldings and trim

K. Clean glass

   1. Exterior

   2. Interior

L. Dust vehicle and deliver

(NOTE: A lacquer job should not be waxed for thirty days after refinishing.)

DETAILING
UNIT V

JOB SHEET #3--DETAIL A COMPLETE ENAMEL PAINT JOB

I. Equipment and materials needed

   A. Hand tool set

   B. Shop towels

   C. Polishing cloth

   D. Lacquer thinner

   E. Compound

   F. Polish

   G. Tire black

II. Procedure

   A. Remove masking from vehicle

   B. Remove overspray

   (NOTE: Lacquer thinner will remove any new enamel finish. Every precaution must be taken to keep it off the new painted surface.)

      1. Chrome moldings and bumpers

      2. Emblems

      3. Trim

      4. Glass

      (NOTE: Watch for painted or plastic inserts. Lacquer thinner may remove paint from moldings or trims.)

   C. Polish

      1. All parts before installing

      2. All moldings, trim, bumpers or other attachments

      3. All interior painted surfaces

JOB SHEET #3

D. Vacuum and dust

  1. Interior

  2. Trunk interior

E. Clean up under hood

F. Wash tires and wheels covers

(NOTE: Refinish wheels if required. Paint black tires if necessary. Use only rubber tire black paint on tires.)

G. Clean glass

  1. Exterior

  2. Interior

H. Dust vehicle and deliver

(IMPORTANT: Dust with a dusting cloth or a soft cloth. Do not use a shop towel as it will scratch the new finish.)

DETAILING
UNIT V

JOB SHEET #4–DETAIL A COMPLETE ENAMEL PAINT JOB ON A COMMERCIAL TRUCK

I. Equipment and materials needed

- A. Hand tool set
- B. Shop towels
- C. Polishing cloth
- D. Lacquer thinner
- E. Compound
- F. Polish
- G. Tire black
- H. Kerosene or solvent

II. Procedure

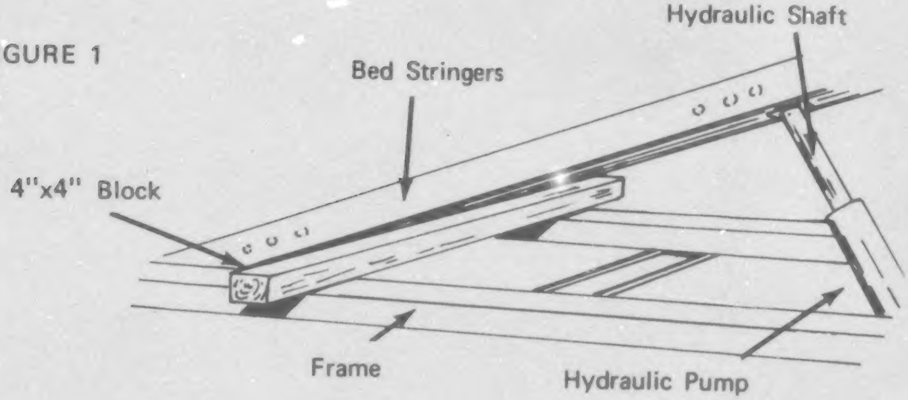
A. Paint frame

(NOTE: Truck frames are usually painted with a chassis black.)

1. Place truck on safety stands
2. Remove wheels from truck
3. Raise truck bed and block (Figure 1)

(CAUTION: If the truck should have a lift type bed, always block the bed up at the point where it intersects the frame to be sure no one is injured by hydraulic pump failure. Do not block just one side.)

FIGURE 1



JOB SHEET #4

4. Tape any part that is not to be painted
    a. Hydraulic shaft

        (NOTE: See Figure 1.)

    b. Cab
    c. Other parts
5. Spray frame

B. Paint wheels

1. Inside
2. Outside

    (NOTE: By using a small pattern and low air pressure, overspray can easily be cleaned from tires with lacquer thinner.)

3. Paint bumpers

C. Remove all masking from truck

D. Clean overspray off of cab

(NOTE: Kerosene or solvent can be used. It will not cut the new paint on the cab, but it will cut the overspray. Clean this up while frame is still wet.)

E. Throw drop cloth over cab and frame and paint bed

F. Clean overspray off of cab (See D above)

(NOTE: If any overspray gets on frame, touch it up with chassis black. All solvents will remove chassis black even when dry.)

G. Remove overspray

(NOTE: Lacquer thinner will remove any new enamel finish. Every precaution must be taken to keep it off the new painted surface.)

1. Chrome moldings and bumpers
2. Emblems
3. Trim
4. Glass

JOB SHEET #4

H. Polish

   1. All parts and install

   2. All moldings, trim, chrome bumpers, or other attachments

   3. All interior painted surfaces

I. Vacuum and dust interior

J. Clean up under hood

K. Wash tires and wheels

(NOTE: If tires and wheels are refinished, do not wash just install.)

L. Clean glass

   1. Exterior

   2. Interior

M. Dust vehicle and deliver

(IMPORTANT: Dust with a dusting cloth or a soft cloth. Do not use a shop towel as it will scratch the new finish.)

DETAILING
UNIT V

TEST

1. Match the following terms with the correct definitions.

_____a. Unwanted, extra paint spray on the surface of chrome, glass, or adjacent panels

_____b. Small specks of foreign material in a dried paint film

_____c. Fine abrasive material in a creamy consistency used either by hand or for machine polishing

_____d. The clean up and get ready operation during spot, panel, or all over refinishing

_____e. Gloss or sheen or brightness of a finish

_____f. Term used to describe an uneven pebbly surface resembling the skin of an orange; appears in a paint film that has been applied by spray

1. Detailing
2. Rubbing compound
3. Dirt nibs
4. Luster
5. Orange peel
6. Overspray

2. Describe the hand compounding method.

3. Name the areas where a polishing buffer cannot be used.

a.

b.

c.

d.

4. Choose from a list of hand rubbing compounds the one that would be used for compounding enamel finishes by placing an "X" in the correct blank.

   _____a. Coarse cut

   _____b. Machine compound

   _____c. Lacquer fast cut

   _____d. Synthetic or extra fine

5. Name the liquid that is used to remove paint overspray.

6. Describe the effect that lacquer thinner has on fresh enamel.

7. Demonstrate the ability to:

   a. Compound, polish, and detail a spot or panel repair.

   b. Compound, polish, and detail a complete lacquer paint job.

   c. Detail a complete enamel paint job.

   d. Detail a complete enamel paint job on a commercial truck.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

DETAILING
UNIT V

ANSWERS TO TEST

1. a. 6
   b. 3
   c. 2
   d. 1
   e. 4
   f. 5

2. Description should include:
   a. Make a ball out of a soft cloth
   b. Place a small amount of rubbing compound on ball of cloth
   c. Rub surface to be compounded with a back and forth motion until rubbing compound is worn off of the surface
   d. Repeat steps B and C until desired luster is achieved
   e. Wipe surface with a clean dry cloth

3. a. Around windows
   b. Around chrome moldings, trim, emblems
   c. Around windshield wipers
   d. On any extruding body panel crease or edge

4. d

5. Lacquer thinner

6. It will wrinkle the finish and the finish will be removed if allowed to come into contact with the thinner

7. Performance skills will be evaluated according to the criteria listed on the progress chart.

Auto Body
PROGRESS CHART

Section I-1
Refinishing

	Unit I Sanding Painted Surfaces								Unit II Stripping Painted Surfaces					Unit III Masking					
	1	2	3	4	5	6	7	8	1	2	3	4	5	1	2	3	4	5	6
Job	Unit Test	Featheredge	Wet Sand for a Complete Paint Job	Dry Sand for a Complete Paint Job	Sand for a Spot Repair	Sand for a Panel Repair	Scuff Sand a Surface		Unit Test	Remove Paint with a Grinder	Remove Lacquer Paint with Lacquer Removing Solvent	Remove Paint with Paint Remover		Unit Test	Mask for Primer	Mask for Spot Repair	Mask for Panel Repair	Mask for Complete Paint Job	
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			

Accuracy

	85% Correct	Uniform Taper from Bare Metal to Top Coat	Surface Dull, all Chips Featheredged & all Surface Blemishes Removed	Surface Dull, all Chips Featheredged & all Surface Blemishes Removed	Top Coat Sanded 6" to 8" Beyond Feathered Edge	Surface of Entire Panel Dull with all Chips Featheredged & Surface Blemishes Removed	All Sanding Marks Parallel to Vehicle to Remove Surface Imperfections			85% Correct	All Paint Removed with a Minimum of Metal Damage	According to Instructions Included with Removing Solvent	According to Instructions Included with Removing Solvent		85% Correct	Mask Sufficiently to Prevent Overspray Build-up	Cover all Areas not to be Sprayed	Mash all Areas Adjacent to the Panel	Mask all Chrome & Trim with no Tops in Area to be Painted	
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				

Auto Body
PROGRESS CHART

Section I-2
Refinishing (continued)

	Unit IV Spraying Automotive Finishes									Unit V Detailing										
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6					
Job	Unit Test	Use the Paint Gun with Proper Technique	Mix Paint	Mix & Apply Undercoats	Mix & Apply Topcoats	Perform a Spot Repair	Perform a Panel Repair	Match Colors		Unit Test	Compound, Polish, & Detail a Spot or Panel Repair	Compound, Polish, & Detail a Complete Lacquer Paint Job	Detail a Complete Enamel Paint Job	Detail a Complete Enamel Paint Job on a Commercial Truck						
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4
85% Correct																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
See Manufacturer's Specifications																	
To Satisfaction of Customer																	
85% Correct																	
No Imperfections, Overspray, or Cleaning & Polishing Residue on Vehicle																	
No Imperfections, Overspray, or Cleaning & Polishing Residue on Vehicle																	

MAKING AN ESTIMATE
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms and definitions associated with estimating, analyze a damaged automobile, and properly write an estimate for repair. He should be able to estimate minor repairs and major repairs as well as paint jobs. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with estimating to a list of definitions.
2. Name the five functions of an estimate.
3. List the three steps of making an estimate.
4. Name the book used to price parts and labor in estimating.
5. Describe the procedure for completing a form for an estimate.
6. Describe the method for determining how a collision occurred.
7. List the factors that determine whether a part is to be repaired or replaced.
8. List the factors that determine the time involved in straightening panels.
9. Fill in the preliminary information on an estimate sheet from available information.
10. Write an estimate to refinish a door using available information.
11. Write an estimate to straighten and refinish a door using available information.
12. Write an estimate to straighten a front and rear door using available information.
13. Write an estimate to straighten and replace parts on a front end assembly using available information.
14. Write an estimate to straighten and replace parts on a total using available information.

MAKING AN ESTIMATE
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and assignment sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information and assignment sheets.
- F. Give test.

II. Students:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete assignment sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency masters
    1. TM 1--Estimate Example
    2. TM 2--Estimate Example (Continued)
    3. TM 3--Estimate Example (Continued)

D. Assignment sheets

1. Assignment Sheet #1--Write an Estimate to Refinish a Door

2. Assignment Sheet #2--Write an Estimate to Straighten and Refinish a Door

3. Assignment Sheet #3--Write an Estimate to Straighten a Front and Rear Door

4. Assignment Sheet #4--Write an Estimate to Straighten and Replace Parts on a Front End Assembly

5. Assignment Sheet #5--Write an Estimate to Straighten and Replace Parts on a Total

E. Test

F. Answers to test

II. References:

A. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

B. MacPherson, Robert C. *Collision Repair Guide*. New York: McGraw-Hill Inc., 1971.

C. *Ford Estimating Paint and Body Repair Training Handbook 20001.3.* Dearborn, Michigan: Ford Motor Co., 1966.

MAKING AN ESTIMATE
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Actual repair cost--The cost as it is listed on the repair order

B. Adjustor--The representative from the insurance company whose job it is to see that his company pays a fair price for repairs and to make sure the customer is satisfied with the repair

C. Assured--The party in whose favor an insurance policy stands

D. Authorization for repairs--Repairs are authorized by the signature of the proper authority, either the owner or the insurance company representative, on the estimate or repair order

E. Combination operation--Two or more disassembly or assembly operations which when accomplished together take less time than they would separately

(NOTE: The combination operation is also referred to as "overlap".)

F. Claimant--The party seeking compensation for injuries or property damage

G. Commitment--Refers to the estimator's obligation to fulfill his promise or pledge in terms of his estimate to do a specified repair for a specified price

(NOTE: A commitment is sometimes referred to as a "firm pledge".)

H. Estimate--A statement describing the work to be done and the amount for which it will be done by the garage that undertakes the job

I. Estimating--Making an appraisal of costs to repair collision damage

J. Deductible--Refers to the deductible provision in policies whereby the insurance company is not responsible for minor damage

K. Detailed labor analysis--A detailed description of each repair operation

L. Facilities and manpower--The facilities and manpower of every shop differ and should have an effect on the estimator's bids for work

M. Fixed pricing--The pricing applied to labor operations which remain essentially the same for every repair, such as the fixed price charged to lubricate a car or to fix a flat

INFORMATION SHEET

N. File copy--The copy of the estimate that the body shop retains in its own files

(NOTE: A copy of the repair order is also usually kept in the service files.)

O. Flat rate--The average time as determined in a factory study to remove and replace an assembly or component

P. Hard copy--The copy of the repair order which stays with the car in the garage to be used as a directive for the actual repair operation

Q. Hidden damage--Damage which is not discovered until after the repair work is underway

(NOTE: Hidden damage is sometimes referred to as "undetected damage".)

R. Independent appraisal company--A company which makes a business of giving independent, unbiased appraisals in cases where there is a disagreement between the insurance company and the repair garage

S. Inspection procedure--The procedure the estimator uses in analyzing and appraising damage

T. Invoice--In collision work, the customer's copy of the repair order is generally used as the invoice or bill

U. Knowledge of repair processes--The knowledge needed to proficiently estimate damage repair costs

V. Labor operation--A repair consisting of a number of labor operations, such as disassembly, bumping, reassembly, leading, contouring, filing, sanding, and painting

W. Legal conditions--The estimate should spell out the legal conditions on which the shop agrees to take on the repair work

X. Minimum parts and minimum labor--One important aspect of estimating which includes determining the minimum number of parts and labor time required to make the repair

Y. Open time--Term used in estimating where the extent of damage cannot be readily determined, such as for a damaged frame or for an automatic transmission

Z. Optimum volume--The work load at which the shop is operating most efficiently

AA. Overhead--The operating expenses of the shop, such as rent, heat, lighting, electricity, depreciation, office and shop supplies, bookkeeping costs, cost of estimates, and other expenses

INFORMATION SHEET

BB. Preliminary information--Owner information, vehicle data, and insurance company data which are filled in on the estimate prior to estimating repair costs

CC. Pricing system--The system used to determine the cost to the customer for the services of the shop

DD. R and R time--The time required to remove and replace an assembly or component

EE. Repair order--Used to direct the repair operation, assign work, and as an authorization for obtaining parts

FF. Retail rate--The rate at which the services of the shop are charged to the customer

GG. Service file--The office file which contains copies of completed work orders

HH. Sublet work--Repair work, such as frame straightening, which has to be sublet to specialists because the shop lacks the equipment to do the job

II. Time and material--A method of estimating repair costs by approximating labor time and cost of materials

JJ. Unforeseen expenses--Expenses not taken into consideration by the estimate either due to undetected damage or complications in the repair work

KK. Work load--The quantity or volume of work handled by the shop in a given time

II. Functions of an estimate

A. Establishes a job commitment

B. Establishes a reasonable price

C. Lists necessary owner and insurance data

D. Serves as an effective sales tool

E. Assists in making a shop efficient and profitable

III. Steps in making an estimate

A. Analyze the damage

B. Inspect the damage by body units

1. Front end assembly

2. Body

3. Rear end assembly

INFORMATION SHEET

    4. Frame
    5. Other units
  C. Price the estimate
    1. List all repairs and parts
    2. Price the estimate

IV. Book used to price parts and labor in estimating--Collision Estimating Manual

V. Procedure for completing a form for an estimate (Transparencies 1,2, and 3)

  A. Record customer information
    1. Name
    2. Address
    3. Home phone
    4. Business phone
    5. Insurance company
    6. Insurance adjustor
    7. Insurance adjustor's phone
  B. Record vehicle information
    1. Vehicle (make)
    2. Year
    3. Model
    4. Body style
    5. License
    6. Mileage
  C. List all repairs by group
  D. Price the estimate
  E. Check repairs and prices

INFORMATION SHEET

F. Compute tax

G. Total the estimate

H. Sign the estimate, give a copy to customer, and file your copy by customer's name

VI. Method for determining how a collision occurred--By the direction and severity of impact; strains in the metal, such as the forward or backward motion or shifting of body panels, relate to the direction of collision

VII. Factors that determine whether a part is repaired or replaced

A. Cost of repair labor

B. Cost of new part

C. Cost of labor for removal and replacement

VIII. Factors that determine the time involved in straightening panels

A. Nature of repair

B. Extent of damage

C. Accessibility for repair

IX. Preliminary information on an estimate sheet

ESTIMATE

PAINT & BODY SHOP

Name Payman Wenner Car Pont Year 73
Address 1515 W. 5th, Stillwater, Okla Mfr. No. GT134 2564
Phone (Home) 377-1234 (Bus.) 377-2001 Mileage 32574
License PA 2375 Model Grand Safari Body Style 4-Door Wagon

Insurance Co. Ajax Policy No. 3574820
Adjusting Co. Jones Claim No. 185274
Adjuster Q. T. Ajax Phone 377-4321

Operation No.	Description of Work	Parts Prices	Labor Hours			Total Labor Hours
			Body	Mech.	Paint	
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Estimate Example

PAINT & BODY SHOP

Name ____ Car ____ Year ____
Address ____ Mfr. No. ____
Phone (Home) ____ (Bus.) ____ Mileage ____
License ____ Model ____ Body Style ____

Insurance Co. ____ Policy No. ____
Adjusting Co. ____ Claim No. ____
Adjuster ____ Phone ____

Operation No.	Description of Work	Parts Prices	Labor Hours			Total Labor Hours
			Body	Mech.	Paint	
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THIS IS NOT A BILL -
ADVANCE ESTIMATE ONLY

This estimate is based on the initial inspection. It does not cover additional parts or labor that might be required after the damaged sections have been removed. Occasionally, worn or damaged parts are found after work has been started which were not evident on the initial inspection, in which case you will be notified.

Estimated by ____ Date ____
Remarks ____

Total Parts Prices ____ $ ____
Total Body Labor @ ____ Hour ____ $ ____
Total Mech. Labor @ ____ Hour ____ $ ____
Total Paint Labor @ ____ Hour ____ $ ____
Paint & Material ____ $ ____
Sublet Repairs ____ $ ____
Towing &/or Advanced Charges ____ $ ____
Sales Tax ____ $ ____
Total Repair Estimate ____ $ ____
Car Owner's Share of Estimate ____ $ ____

Estimate Example

(Continued)

ESTIMATE OF REPAIRS

DATE ______________________

EST. NO. ______________________

SHEET ________ OF ____________

	ADDRESS				PHONE HOME BUSINESS	LICENSE NUMBER
& MODEL OF CAR	YEAR	TYPE	PAINT CODE	TRIM CODE	MILEAGE	VEHICLE I.D. NUMBER
INSURANCE CO.	TYPE OF COVERAGE		ADJUSTOR		PHONE HOME BUSINESS	POLICY NO.

REPAIR	REPLACE	DESCRIPTION	PARTS			LABOR		PAINT		TOTAL	
			NUMBER	AMOUNT							
			TOTAL								
			TAX								
			WRECKER SERVICE								
			TOTAL ESTIMATE								

REMARKS ____

____

____

____

THIS ESTIMATE IS BASED ON OUR INSPECTION AND DOES NOT COVER ADDITIONAL PARTS OR LABOR WHICH MAY BE REQUIRED AFTER THE WORK HAS BEEN STARTED. AFTER THE WORK HAS STARTED, WORN OR DAMAGED PARTS WHICH ARE NOT EVIDENT ON FIRST INSPECTION MAY BE DISCOVERED. NATURALLY THIS ESTIMATE CANNOT COVER SUCH CONTINGENCIES. PARTS PRICES SUBJECT TO CHANGE WITHOUT NOTICE. THIS ESTIMATE IS FOR IMMEDIATE ACCEPTANCE.

CUSTOMER PAYS	INSURANCE CO. PAYS
ESTIMATE MADE BY	
AUTHORIZATION TO WORK	
SIGNED	DATE

Estimate Example
(Continued)
ESTIMATE OF REPAIR COSTS

OWNER: DATE:

ADDRESS: PHONE:

Year	Make	Body Style	Mileage	License

FRONT	Net	Hrs.	Parts	FRONT	Net	Hrs.	Parts
Bumper				Horn			
Arms				Headlamp			
Guard				Door			
Guard Rail				Sealed Beam			
Gravel Guard				Retainer			
				Battery			
				Park'g Lamp			
Wheel							
Hub Cap							
Hub & Drum				Hood			
Knuckle				Hood Mould'g			
Up.Cont.Arm-Shaft				Hood Lock Pl.			
Lr.Cont.Arm-Shaft				Hood Hinges			
Ball Joints				Medallion			
				Ornament			
Frt. System				Baffle			
				Fender			
Tie Rod				Moulding			
Drag Link				Name Plate			
Steer'g Gear				Skin			
Steer'g Wheel				Air Duct			
Horn Ring				Aerial			
Tire							
				Fender			
				Moulding			
Grill Panel				Name Plate			
Moulding				Skin			
Vrt. Moulding							
Medallion				Windsh'd Tint Clear			
Extension				Moulding			
Ext. Mould'g				Moulding			
				Top			
Air Cond.				Frame			
Condenser							
Receiver				Motor Supp't			
Line							
Radiator Core							
Core Support							
Core Baffle							
Fan							
Water Pump							
Hose							

REAR	Net	Hrs.	Parts
Bumper			
Arms			
Guard			
Guard Rail			
Lower Panel			
Floor			
Quarter R. Inner Outer			
Quarter L. Inner Outer			
Quarter Ext.			
Moulding			
Trunk Lid			
Hinge			
Handle			
Medallion			
Tail Light			
License Lt.			
Tail Pipe			
Gas Tank			
Door			
Glass Tint Clear			
Door Handle			
Moulding			
Door			
Glass Tint Clear			
Door Handle			
Moulding			
Seat			
Seat Adj.			
Center Post			
Rocker Panel			
Moulding			
Painting			
Under Coat			
GROSS TOTAL			

LABOR HRS.	@	$	
PARTS LESS %	$	$	
NET		$	
WRECKER		$	
TAX		$	
	TOTAL	$	

AUTHORIZATION TO REPAIR

X______________________________

THE ABOVE IS AN ESTIMATE BASED ON OUR INSPECTION AND DOES NOT COVER ANY ADDITIONAL PARTS OR LABOR WHICH MAY BE REQUIRED AFTER THE WORK HAS BEEN OPENED UP. BECAUSE OF TIME THE ABOVE PRICES ARE NOT GUARANTEED.

A-Align 1-2-New OH-Overhaul S-Straighten R-Repair

MAKING AN ESTIMATE
UNIT I

ASSIGNMENT SHEET #1--WRITE AN ESTIMATE TO REFINISH A DOOR

1. Owner--Roy Byers, 1225 West Avenue, Your town, USA, home phone--234-5678, business phone--234-8765

2. Vehicle--This year's Ford LTD, 2-door sedan, license--GA 1264, mileage--31,725, No. 54A25A271

3. Insurance information--Ajax Insurance Co., 526 Main St., policy M456832, adjustor--A. B. Bender, Bender Adjustment Co., phone--234-9000, claim 74582

   (NOTE: Student must estimate the amount of paint materials used or use the standard percentage of labor for the area.)

18-J

ASSIGNMENT SHEET #1

Name ____________ Car ______ Year ______
Address ____________ Mfr. No. ______
Phone (Home) ______ (Bus.) ______ Mileage ______
License ______ Model ______ Body Style ______

Insurance Co. ______ Policy No. ______
Adjusting Co. ______ Claim No. ______
Adjuster ______ Phone ______

Operation No.	Description of Work	Parts Prices	Labor Hours			Total Labor Hours
			Body	Mech.	Paint	
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This estimate is based on the initial inspection. It does not cover additional parts or labor that might be required after the damaged sections have been removed. Occasionally, worn or damaged parts are found after work has been started which were not evident on the initial inspection, in which case you will be notified.

Estimated by ____________ Date ______

Remarks ____________

National Market Reports Inc., Chicago
Printed in U.S.A.,

FORM 170

Total Parts Prices ______ $______
Total Body Labor @ ______ Hour ______ $______
Total Mech. Labor @ ______ Hour ______ $______
Total Paint Labor @ ______ Hour ______ $______
Paint & Material ______ $______
Sublet Repairs ______ $______
Towing &/or Advanced Charges ______ $______
Sales Tax ______ $______
Total Repair Estimate ______ $______
Car Owner's Share of Estimate ______ $______

MAKING AN ESTIMATE
UNIT I

ASSIGNMENT SHEET #2–WRITE AN ESTIMATE TO STRAIGHTEN AND REFINISH A DOOR

1. Owner–Paymen Wenner, 1285 Stillberry Ave., Your town, USA, home phone–377-1234

2. Vehicle–This year's Pontiac Grand Safari, station wagon, 4-door, license–PA 2000, mileage–00363, No. 18652342

3. Insurance information–Travelers Insurance Co., 1200 W. 6th St., policy M456832

4. Body labor time–3.7 hours

   (NOTE: Student must estimate the amount of paint materials used or use the standard percentage of labor for the area.)

20-J

ASSIGNMENT SHEET #2

Name ______________________ Car __________ Year __________
Address ______________________ Mfr. No. __________
Phone (Home) __________ (Bus.) __________ Mileage __________
License __________ Model __________ Body Style __________

Insurance Co. __________ Policy No. __________
Adjusting Co. __________ Claim No. __________
Adjuster __________ Phone __________

Operation No.	Description of Work	Parts Prices	Labor Hours			Total Labor Hours
			Body	Mech.	Paint	
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Estimated by ______________________ Date __________
Remarks ______________________

Total Parts Prices __________ $ __________
Total Body Labor @ __________ Hour __________ $ __________
Total Mech. Labor @ __________ Hour __________ $ __________
Total Paint Labor @ __________ Hour __________ $ __________
Paint & Material __________ $ __________
Sublet Repairs __________ $ __________
Towing &/or Advanced Charges __________ $ __________
Sales Tax __________ $ __________
Total Repair Estimate __________ $ __________
Car Owner's Share of Estimate __________ $ __________

National Market Reports Inc., Chicago FORM 170
Printed in U.S.A.,

1068

MAKING AN ESTIMATE
UNIT I

ASSIGNMENT SHEET #3--WRITE AN ESTIMATE TO STRAIGHTEN A FRONT AND REAR DOOR

1. Owner--Leonard Corkley, 1725 Squaresville Drive, Your City, USA, business phone--PQ4-3785

2. Vehicle--This year's Chevrolet Caprice, 2-door hard top, license--PA 578

3. Insurance information--No insurance

4. Body labor time

   a. Front door--.7

   b. Rear door--3.5

   (NOTE: Student must estimate the amount of paint materials to be used or use the standard percentage of labor for the area.)

22-J

ASSIGNMENT SHEET #3

Name ____________________ Car __________ Year __________

Address ____________________ Mfr. No. __________

Phone (Home) __________ (Bus.) __________ Mileage __________

License __________ Model __________ Body Style __________

Insurance Co. __________ Policy No. __________

Adjusting Co. __________ Claim No. __________

Adjuster __________ Phone __________

Operation No.	Description of Work	Parts Prices	Labor Hours Body	Labor Hours Mech.	Labor Hours Paint	Total Labor Hours
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Estimated by ____________________ Date __________

Remarks ____________________

National Market Reports Inc., Chicago
Printed in U.S.A.,
FORM 170

Total Parts Prices ____________ $ ______
Total Body Labor @ ______ Hour ______ $ ______
Total Mech. Labor @ ______ Hour ______ $ ______
Total Paint Labor @ ______ Hour ______ $ ______
Paint & Material ____________ $ ______
Sublet Repairs ____________ $ ______
Towing &/or Advanced Charges ____________ $ ______
Sales Tax ____________ $ ______
Total Repair Estimate ____________ $ ______
Car Owner's Share of Estimate ____________ $ ______

MAKING AN ESTIMATE
UNIT I

ASSIGNMENT SHEET #4--WRITE AN ESTIMATE TO STRAIGHTEN AND REPLACE PARTS ON A FRONT END ASSEMBLY

1. Owner--Jack Heffer, 1274 W. 1st St., Your town, USA, home phone--YQ7-3859, business phone--ZQ4-8765

2. Vehicle--This year's Chevrolet Impala, 4-door hardtop, license--786-543, mileage--08564, No. 186M594

3. Insurance information--Your State Insurance Group, 725 Central Ave., New York City, New York, Crashers Adjustments Co., phone--YZ4-8000, claim 85743

4. Replacement parts

    a. Front bumper face bar

    b. Bumper energy absorber

    c. Grill

    d. Panel above grill

    e. Radiator

    f. Front fender wheel opening molding

    g. Nameplate

5. Body panels to be repaired

    a. Hood--1.3

    b. Front fender--3.4

    c. Front fender inner panel--.7

    (NOTE: Student must estimate the amount of paint materials to be used or use the standard percentage of labor for the area.)

24-J

ASSIGNMENT SHEET #4

Name ________ Car ________ Year ________
Address ________ Mfr. No. ________
Phone (Home) ________ (Bus.) ________ Mileage ________
License ________ Model ________ Body Style ________

Insurance Co. ________ Policy No. ________
Adjusting Co. ________ Claim No. ________
Adjuster ________ Phone ________

Operation No.	Description of Work	Parts Prices	Labor Hours			Total Labor Hours
			Body	Mech.	Paint	
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ADVANCE ESTIMATE ONLY

This estimate is based on the initial inspection. It does not cover additional parts or labor that might be required after the damaged sections have been removed. Occasionally, worn or damaged parts are found after work has been started which were not evident on the initial inspection, in which case you will be notified.

Estimated by ________ Date ________

Remarks ________

National Market Reports Inc., Chicago
Printed in U.S.A.,
FORM 170

Total Parts Prices ________ $ ________
Total Body Labor @ ________ Hour ____ . ____ $ ________
Total Mech. Labor @ ________ Hour ____ . ____ $ ________
Total Paint Labor @ ________ Hour ____ . ____ $ ________
Paint & Material ________ $ ________
Sublet Repairs ________ $ ________
Towing &/or Advanced Charges ________ $ ________
Sales Tax ________ $ ________
Total Repair Estimate ________ $ ________
Car Owner's Share of Estimate ________ $ ________

MAKING AN ESTIMATE
UNIT I

ASSIGNMENT SHEET #5--WRITE AN ESTIMATE TO STRAIGHTEN AND REPLACE PARTS ON A TOTAL

1. Owner--Busy Bee Oil Co., 7584 Oilfield Road, Your City, USA, home phone--548-7584
2. Vehicle--This year' Chevrolet 1/2 ton CIO 8 foot Fleetside
3. Insurance information--Max Trie Adjustments, phone--238-5480, claim 547832
4. Replacement parts
    a. Top of cab
    b. Right and left doors
    c. Back of cab
    d. All glass and channels
    e. Hood
    f. Right and left fenders
    g. Right bed side
    h. Motor mounts
5. Repairable items
    a. Frame--10.7 hours
    b. Left bed side--4.3 hours
    c. Cowl--7.8 hours

    (NOTE: Student must estimate the amount of paint materials be to used or use the standard percentage of labor for the area.)

26-J

ASSIGNMENT SHEET #5

Name ____________ Car ________ Year ________
Address ____________ Mfr. No. ____________
Phone (Home) ________ (Bus.) ________ Mileage ________
License ________ Model ________ Body Style ________

Insurance Co. ____________ Policy No. ____________
Adjusting Co. ____________ Claim No. ____________
Adjuster ____________ Phone ____________

Operation No.	Description of Work	Parts Prices	Labor Hours			Total Labor Hours
			Body	Mech.	Paint	
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THIS IS NOT A BILL -
ADVANCE ESTIMATE ONLY

This estimate is based on the initial inspection. It does not cover additional parts or labor that might be required after the damaged sections have been removed. Occasionally, worn or damaged parts are found after work has been started which were not evident on the initial inspection, in which case you will be notified.

Estimated by ____________ Date ________

Remarks ____________

National Market Reports Inc., Chicago
Printed in U.S.A., FORM 170

Total Parts Prices ____________ $________
Total Body Labor @ ________ Hour ___ . ___ $________
Total Mech. Labor @ ________ Hour ___ . ___ $________
Total Paint Labor @ ________ Hour ___ . ___ $________
Paint & Material ____________ $________
Sublet Repairs ____________ $________
Towing &/or Advanced Charges ____________ $________
Sales Tax ____________ $________
Total Repair Estimate ____________ $________
Car Owner's Share of Estimate ____________ $________

MAKING AN ESTIMATE
UNIT I

TEST

1. Match the following terms with the correct definitions.

_____a. Repair work, such as frame straightening, which has to be sublet to specialists because the shop lacks the equipment to do the job

_____b. The representative from the insurance company whose job it is to see that his company pays a fair price for repairs and to make sure the customer is satisfied with the repair

_____c. A company which makes a business of giving independent, unbiased appraisals in cases where there is a disagreement between the insurance company and the repair garage

_____d. Used to direct the repair operation, assign work, and as an authorization for obtaining parts

_____e. The pricing applied to labor operations which remain essentially the same for every repair, such as the fixed price charged to lubricate a car or to fix a flat

_____f. Damage which is not discovered until after the repair work is underway

_____g. One important aspect of estimating which includes determining the minimum number of parts and labor time required to make the repair

1. Assured
2. Claimant
3. Authorization for repairs
4. Estimate
5. Detailed labor analysis
6. Actual repair cost
7. Commitment
8. Estimating
9. Adjustor
10. Deductible
11. Combination operation
12. Hard copy
13. Independent appraisal company
14. Labor operation
15. Legal conditions
16. Facilities and manpower
17. Fixed pricing
18. File copy

______h. Making an appraisal of costs to repair collision damage

______i. Two or more disassembly or assembly operations which when accomplished together take less time than they would separately

______j. The rate at which the services of the shop are charged to the customer

______k. A repair consisting of a number of labor operations, such as disassembly, bumping, reassembly, leading, contouring, filing, sanding, and painting

______l. The facilities and manpower of every shop differ and should have an effect on the estimator's bids for work

______m. A detailed description of each repair operation

______n. The office file which contains copies of completed work orders

______o. Refers to the deductible provision in policies whereby the insurance company is not responsible for minor damage

______p. Expenses not taken into consideration by the estimate either due to undetected damage or complications in the repair work

______q. A statement describing the work to be done and the amount for which it will be done by the garage that undertakes the job

______r. The cost as it is listed on the repair order

19. Hidden damage
20. Flat rate
21. Inspection procedure
22. Knowledge of repair processes
23. Invoice
24. Optimum volume
25. Pricing system
26. Repair order
27. Minimum parts and minimum labor
28. Open time
29. Work load
30. Time and material
31. Service file
32. R and R time
33. Preliminary information
34. Overhead
35. Retail rate
36. Unforeseen expenses
37. Sublet work

_____s. Refers to the estimator's obligation to fulfill his promise or pledge in terms of his estimate to do a specified repair for a specified price

_____t. The work load at which the shop is operating most efficiently

_____u. The time required to remove and replace an assembly or component

_____v. The system used to determine the cost to the customer for the services of the shop

_____w. The procedure the estimator uses in analyzing and appraising damage

_____x. Owner information, vehicle data, and insurance company data which are filled in on the estimate prior to estimating repair costs

_____y. The party in whose favor an insurance policy stands

_____z. The average time as determined in a factory study to remove and replace an assembly or component

____aa. A method of estimating repair costs by approximating labor time and costs of materials

____bb. The operating expenses of the shop, such as rent, heat, lighting, electricity, depreciation, office and shop supplies, bookkeeping costs, cost of estimates, and other expenses ____cc. Repairs are authorized by the signature of the proper authority, either the owner or the insurance company representative, on the estimate or repair order

____dd. Term used in estimating where the extent of damage cannot be readily determined, such as for a damaged frame or automatic transmission

____ee. The party seeking compensation for injuries or property damage

____ff. The knowledge needed to proficiently estimate damage repair costs

____gg. The quantity or volume of work handled by the shop in a given time

____hh. In collision work, the customer's copy of the repair order is generally used as the invoice or bill

____ii. The estimate should spell out the legal conditions on which the shop agrees to take on the repair work

____jj. The copy of the estimate that the body shop retains in its own files

____kk. The copy of the repair order which stays with the car in the garage to be used as a directive for the actual repair operation

2. Name the five functions of an estimate.

a.

b.

c.

d.

e.

3. List three steps to successfully make an estimate.
    a.
    b.
    c.
4. Name the book used to price parts and labor in estimating.
5. Describe the procedure for completing a form for an estimate.
6. Describe the method for determining how a collision occurred.
7. List the factors that determine whether a part is repaired or replaced.
    a.
    b.
    c.
8. List the factors that determine the time involved in straightening panels.
    a.
    b.
    c.

9. Fill in the preliminary information on an estimate sheet from the available information given below.

   a. Owner--Payman Wenner, 1515 W. 6th St. Stillwater, Oklahoma, home phone--377-1234, business phone--377-2000

   b. Vehicle--1973 Pontiac Bonneville, 4-door station wagon, No. GT13425649, mileage--32,574, license--AA 2375

   c. Insurance information--Ajax Insurance Co., policy--3574820, Adjusting Co, claim 185274, adjustor--Q. F. Agres, phone--377-4321

Name ______ Car ______ Year ______
Address ______ Mfr. No. ______
Phone (Home) ______ (Bus.) ______ Mileage ______
License ______ Model ______ Body Style ______

Insurance Co. ______ Policy No. ______
Adjusting Co. ______ Claim No. ______
Adjuster ______ Phone ______

Operation No.	Description of Work	Parts Prices	Labor Hours			Total Labor Hours
			Body	Mech.	Paint	
			.	.	.	.
			.	.	.	.
			.	.	.	.
			.	.	.	.
			.	.	.	.
			.	.	.	.

10. Write an estimate to refinish a door using available information.

11. Write an estimate to straighten and refinish a door using available information.

12. Write an estimate to straighten a front and rear door using available information.

13. Write an estimate to straighten and replace parts on a front end assembly using available information.

14. Write an estimate to straighten and replace parts on a total using available information.

    (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

MAKING AN ESTIMATE
UNIT I

ANSWERS TO TEST

1. a. 37
   b. 9
   c. 13
   d. 26
   e. 17
   f. 19
   g. 27
   h. 8
   i. 11
   j. 35
   k. 14
   l. 16
   m. 5
   n. 31
   o. 10
   p. 36
   q. 4
   r. 6
   s. 7
   t. 24
   u. 32
   v. 25
   w. 21
   x. 33
   y. 1
   z. 20
   aa. 30
   bb. 34
   cc. 3
   dd. 28
   ee. 2
   ff. 22
   gg. 29
   hh. 23
   ii. 15
   jj. 18
   kk. 12

2. a. Establishes a job commitment
   b. Establishes a reasonable price
   c. Lists necessary owner and insurance data
   d. Serves as an effective sales tool
   e. Assists in making a shop efficient and profitable

3. a. Analyze the damage
   b. Inspect the damage by body units
      1) Front end assembly
      2) Body
      3) Rear end assembly

            - 4) Frame
            - 5) Other units
        - c. Price the estimate
            - 1) List all repairs and parts
            - 2) Price the estimate
4. Collision Estimating Manual
5. Description should include:
    - a. Record customer information
        - 1) Name
        - 2) Address
        - 3) Home phone
        - 4) Business phone
        - 5) Insurance company
        - 6) Insurance adjustor
        - 7) Insurance adjustor's phone
    - b. Record vehicle information
        - 1) Vehicle (make)
        - 2) Year
        - 3) Model
        - 4) Body style
        - 5) License
        - 6) Mileage
    - c. List all repairs by group
    - d. Price the estimate
    - e. Check repairs and prices
    - f. Compute tax
    - g. Total the estimate
    - h. Sign the estimate, give a copy to customer, and file your copy by customer's name

6. Method for determining how a collision occurred--By the direction and severity of impact; strains in the metal, such as the forward or backward motion or shifting of body panels, relate to the direction of collision

7. a. Cost of repair labor

   b. Cost of new part

   c. Cost of labor for removal and replacement

8. a. Nature of repair

   b. Extent of damage

   c. Accessibility for repair

9.

Name Payman Wenner Car Pontiac Year 73
Address 1515 W. 6th Stillwater, Okla. Mfr. No. GT13425649
Phone (Home) 377-1234 (Bus.) 377-2000 Mileage 32,754
License AA 2375 Model Bonneville Body Style 4-Door Wagon

Insurance Co. Ajax Policy No. 3574820
Adjusting Co. Adjusting Claim No. 185274
Adjuster Q.F. Agar Phone 377-4321

Operation No.	Description of Work	Parts Prices	Labor Hours			Total Labor Hours
			Body	Mech.	Paint	
			.	.	.	.
			.	.	.	.
			.	.	.	.
			.	.	.	.
			.	.	.	.
			.	.	.	.
			.	.	.	.
			.	.	.	.

10.-14. Performance skills will be evaluated according to the criteria listed on the progress chart.

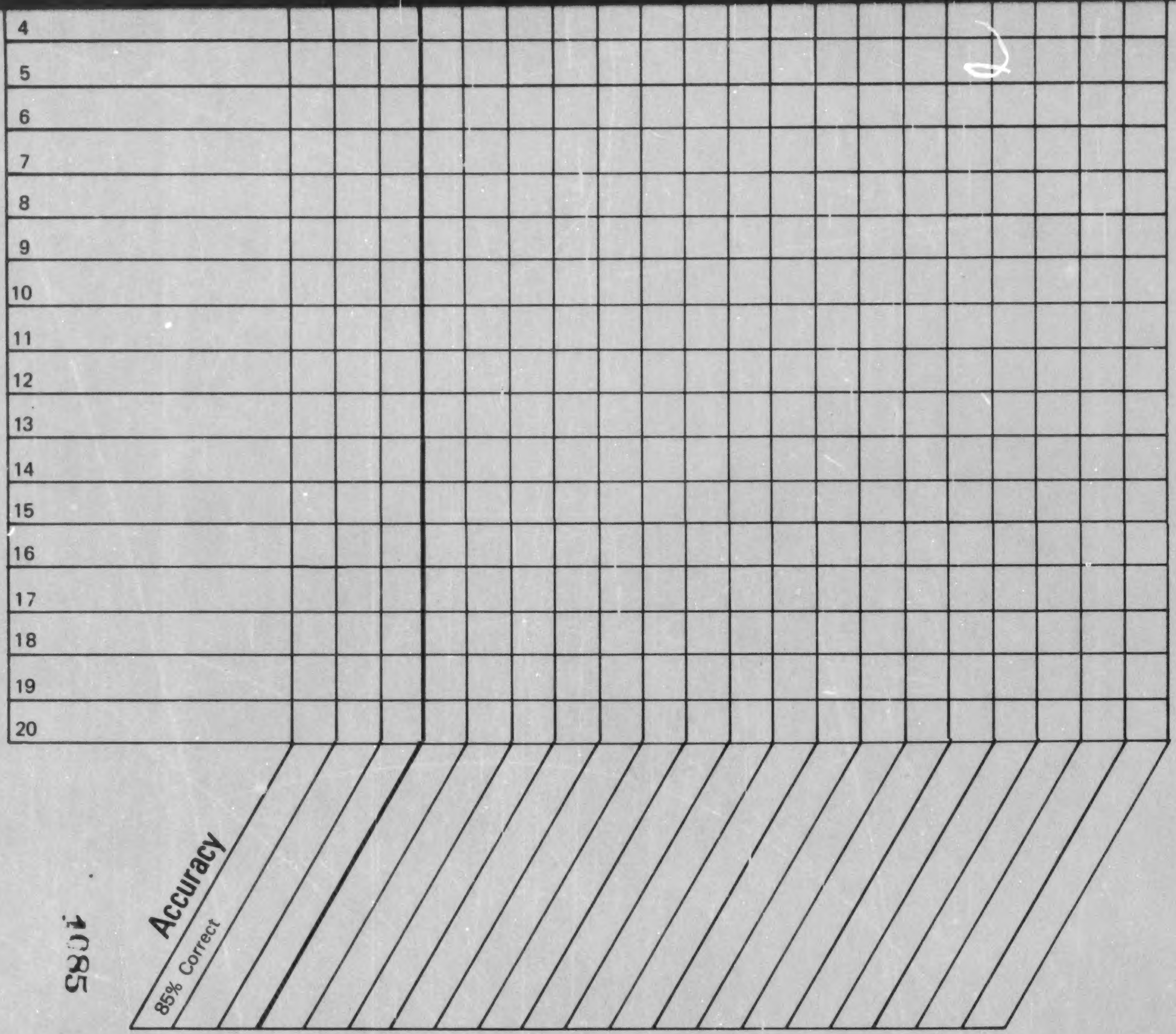
Auto Body
PROGRESS CHART

Section J
Damage Estimating

Job

Unit Test

	Unit I Making an Estimate																			
	1	2	3																	
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				


4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Accuracy
85% Correct

BASIC MEASUREMENT
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to identify tools used in measuring. He should be able to distinguish between 1/8 inch and 1/16 *inch scale* rules and demonstrate the ability to read rules and tapes to the 16ths scale. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify five tools used in basic measuring.
2. Distinguish between a 1/8 inch graduation rule and a 1/16 inch graduation rule.
3. Demonstrate the ability to:
    a. Read a rule when given a drawing and the different locations on the rule.
    b. Read a rule and measure objects to the proper dimensions.
    c. Draw lines and objects to the proper dimensions.

BASIC MEASUREMENT
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and assignment sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information and assignment sheets.

  F. Collect different types of rules and tapes and demonstrate how each one reads to the students.

  G. Give test.

II. Student:

  A. Read objectives.

  B. Study information sheet.

  C. Complete assignment sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency masters

    1. TM 1--Types of Measuring Tools

    2. TM 2--Reading the Eighths Rule

    3. TM 3--Reading the Sixteenths Rule

D. Assignment sheets

1. Assignment Sheet #1--Reading a Rule

2. Assignment Sheet #2--Reading the Rule and Measuring Objects

3. Assignment Sheet #3--Drawing Lines and Objects According to Dimensions

E. Answers to assignment sheets

F. Test

G. Answers to test

II. Reference--*Stanley Tool Guide*. Division of the Stanley Works, Educational Department, New Britain, Connecticut.

BASIC MEASUREMENT
UNIT I

INFORMATION SHEET

I. Types of measuring tools (Transparency 1)

  A. Rule

  B. Steel tape

  C. Yard stick

  D. Zig-zag rule

  E. Steel framing square

II. Reading a rule

  A. Rules read similarly

  (NOTE: Some rules are graduated with more divisions per inch than others.)

  B. Procedures for reading

    1. Determine size of division

      a. Locate small figure near division lines

      b. Count divisions in one inch

      c. Compare with another rule on which divisions are given

      d. Judgment acquired after considerable practice

    2. Count divisions of size indicated from zero to the last whole inch and add to the whole inch

    3. Reduce the answer if possible

    4. Examples--Using the drawing find the distance from O to A

      a. First--The small eight indicates that the divisions are one-eighth inch

      b. Second--From 0 at the end to A, there are five spaces; therefore, five-eighths inch is the measurement

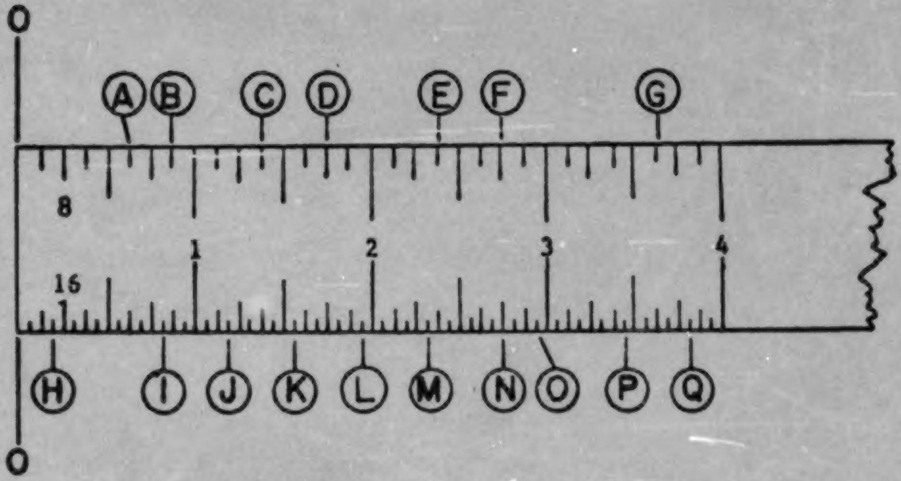
INFORMATION SHEET

5. Using the drawing find the distance from H to K

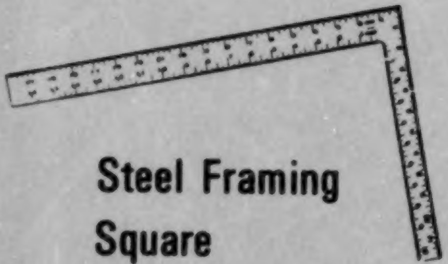
   a. First--The small 16 indicates that the divisions are 1/16 inch

   b. Second--By counting the divisions, there are 22 spaces from H to K which equal 22/16 inches

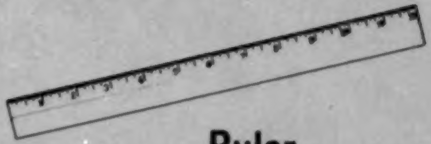
Solution 1.	22/16 = 1 6/16 inches = 1 3/8 inches
Solution 2.	H is at 3/16 inch, K is at 1 9/16 inches 1 9/16 inches - 3/16 inch = 1 6/16 inches = 1 3/8 inches
Solution 3.	From H to 1 inch is 13/16 inch, from 1 inch to K is 9/16 inch 13/16 inch + 9/16 inch = 1 6/16 inches = 1 3/8 inches



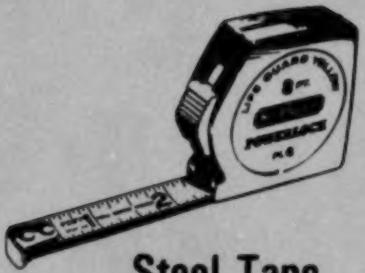
Types of Measuring Tools



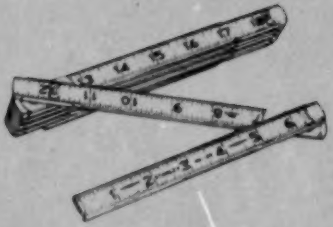
Steel Framing
Square



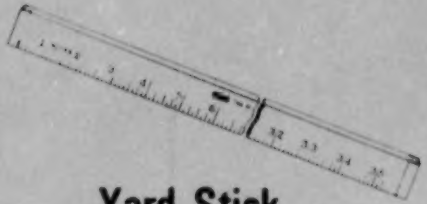
Ruler



Steel Tape

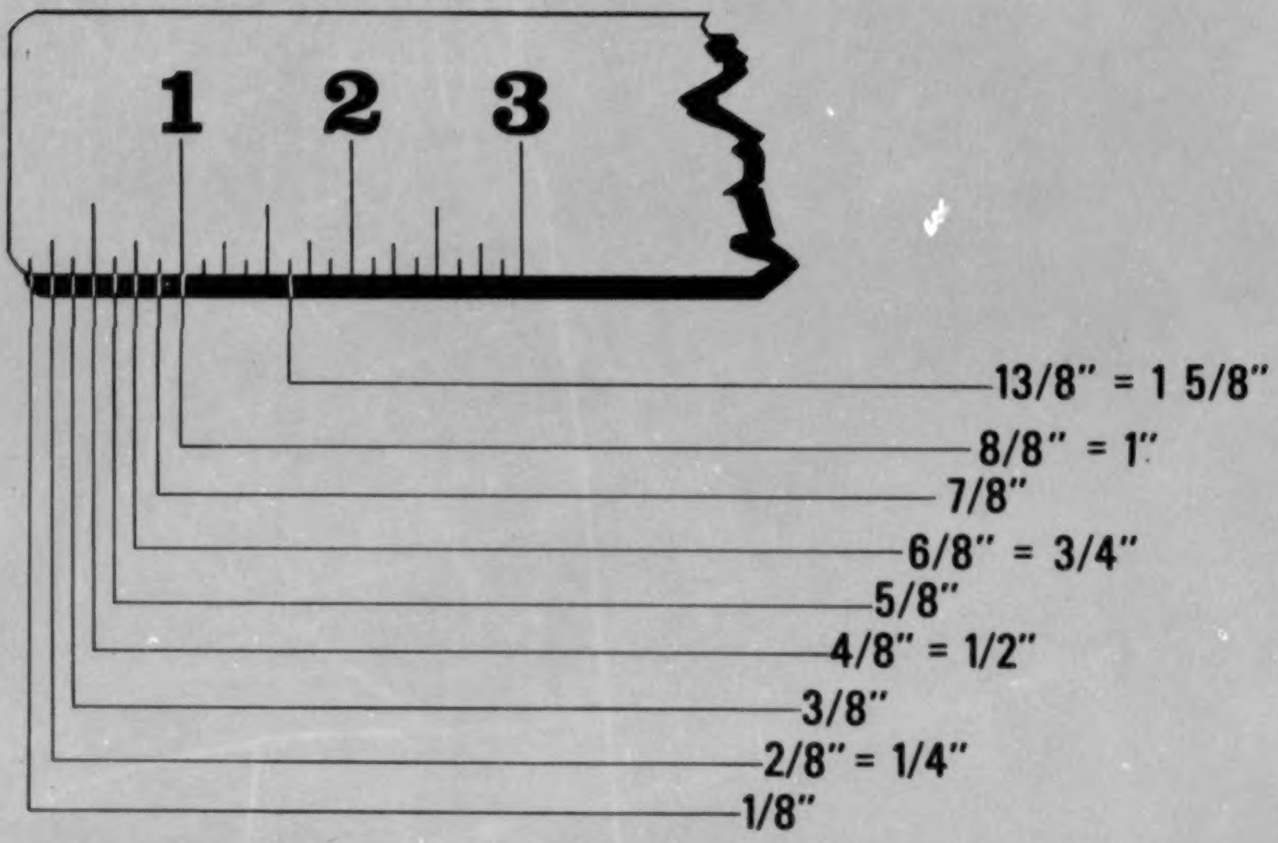


Zig-Zag Ruler

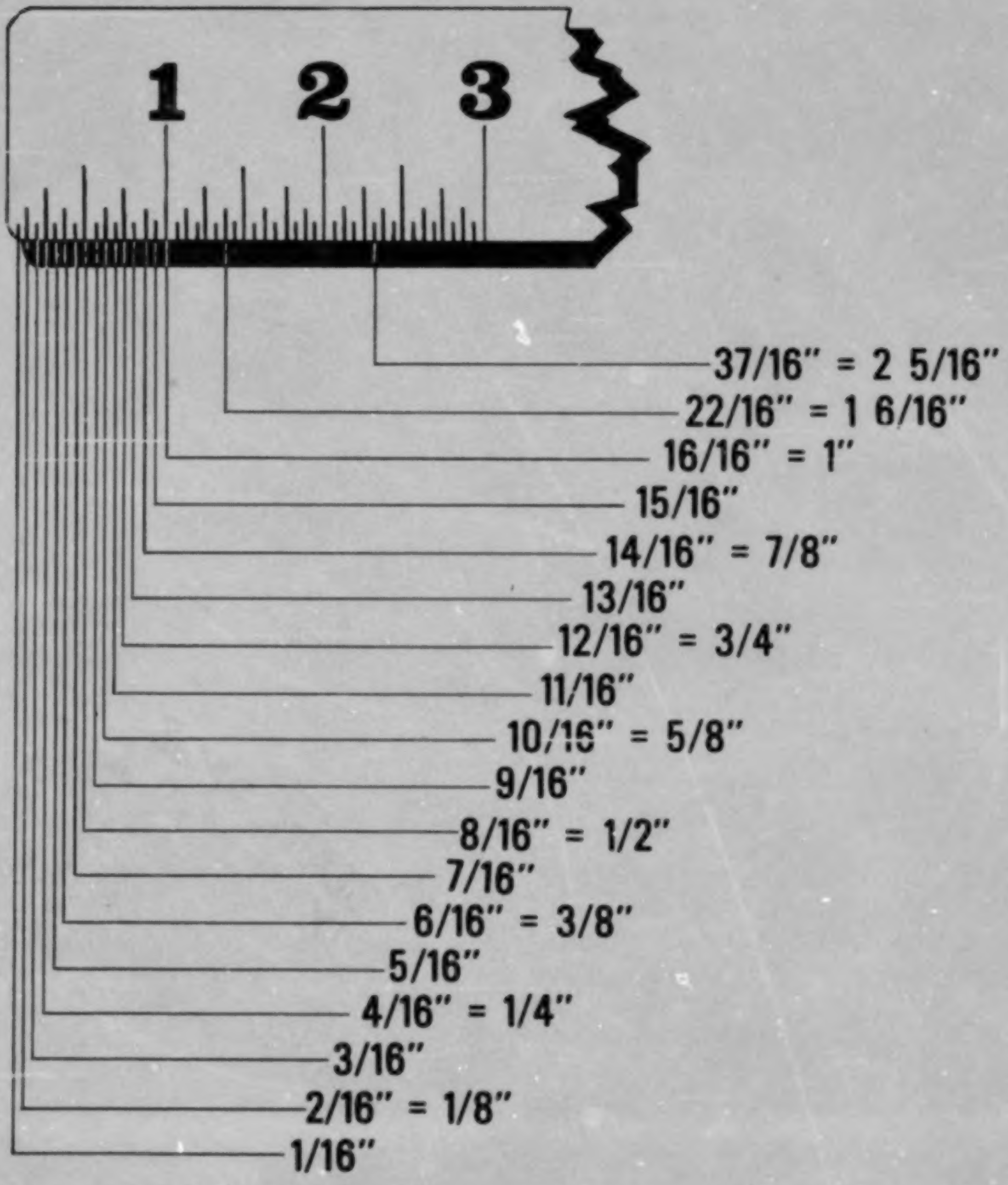


Yard Stick

Reading the Eighths Rule


1
2
3
13/8" = 1 5/8"
8/8" = 1"
7/8"
6/8" = 3/4"
5/8"
4/8" = 1/2"
3/8"
2/8" = 1/4"
1/8"

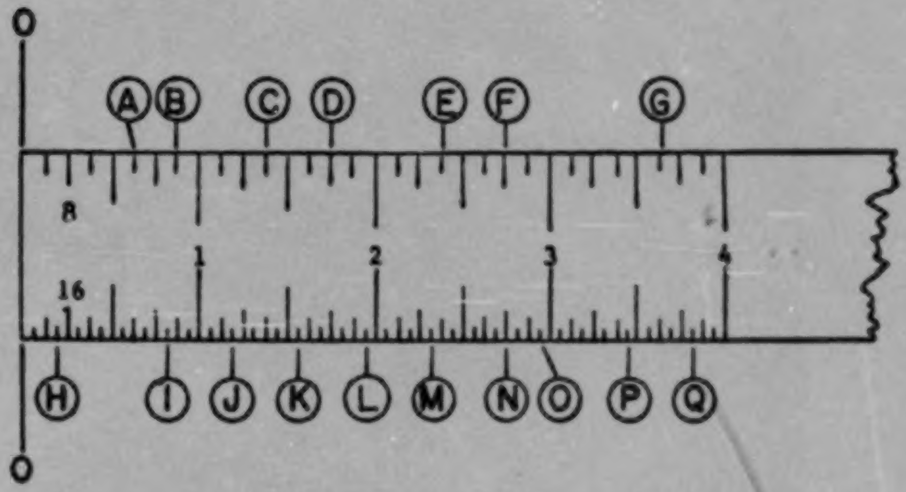
Reading the Sixteenths Rule


1
2
3
37/16" = 2 5/16"
22/16" = 1 6/16"
16/16" = 1"
15/16"
14/16" = 7/8"
13/16"
12/16" = 3/4"
11/16"
10/16" = 5/8"
9/16"
8/16" = 1/2"
7/16"
6/16" = 3/8"
5/16"
4/16" = 1/4"
3/16"
2/16" = 1/8"
1/16"

BASIC MEASUREMENT
UNIT I

ASSIGNMENT SHEET #1--READING A RULE

Use the drawing below and work the following exercises.


0
A
B
C
D
E
F
G
8
1
2
3
4
16
H
I
J
K
L
M
N
O
P
Q
0

Find the distance between the following letters.

1. 0 to B __________

2. 0 to E __________

3. B to G __________

4. D to F __________

5. O to L __________

6. H to J __________

7. K to Q __________

8. M to Q __________

9. K to L __________

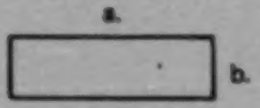
10. I to Q __________

BASIC MEASUREMENT
UNIT I

ASSIGNMENT SHEET #2–READING THE RULE AND MEASURING OBJECTS

Using a 1/16 inch scale rule, measure the following objects.

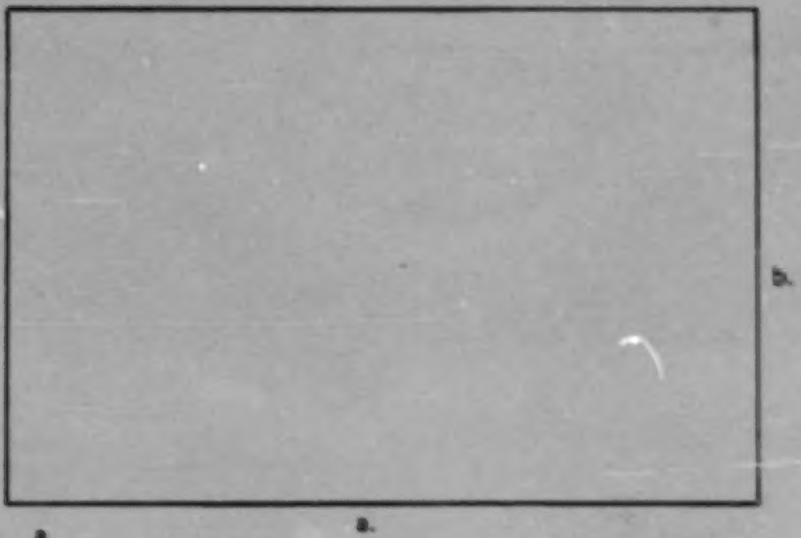
1.



a. Length ____________

b. Width ____________

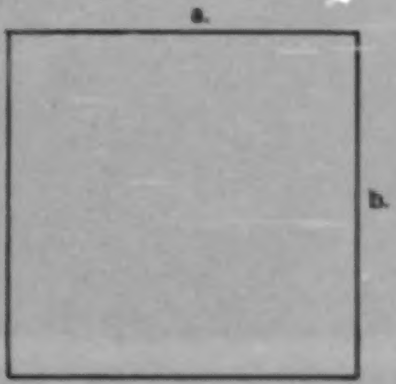
2.



a. ____________

b. ____________

3.

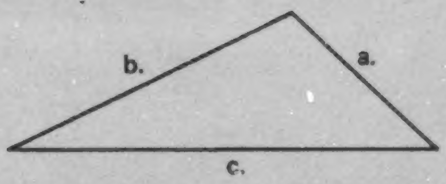


a. ____________

b. ____________

ASSIGNMENT SHEET #2

4.



a. ____________

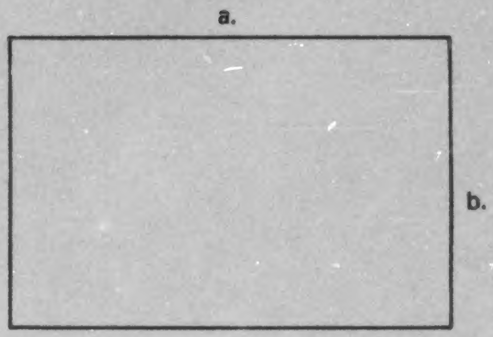
b. ____________

c. ____________

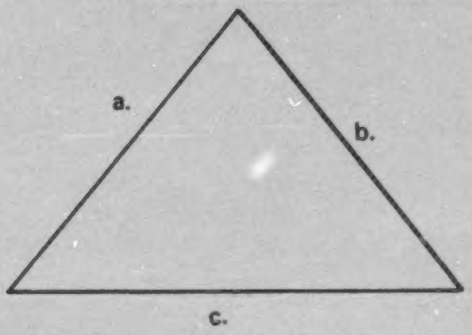
5.

a. Length ____________

b. Width ____________



6.



a. ____________

b. ____________

c. ____________

BASIC MEASUREMENT
UNIT I

ASSIGNMENT SHEET #3--DRAWING LINES AND OBJECTS ACCORDING TO DIMENSIONS

1. Draw straight lines using the following dimensions.
    a. 3 3/4 inches
    b. 2 1/16 inches
    c. 2 10/16 inches
    d. 1 14/16 inches
    e. 2 1/4 inches
2. Draw a square 1 7/8 inches.

3. Draw a triangle using the following dimensions: 1 1/2 inches by 1 inch by 2 3/4 inches.

BASIC MEASUREMENT
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. 7/8 inch
2. 2 3/8 inches
3. 2 6/8 inches = 2 3/4 inches
4. 8/8 inch = 1 inch
5. 1 15/16 inches
6. 16/16 inch = 1 inch
7. 2 4/16 inches - 2 1/4 inches
8. 1 8/16 inches = 1 1/2 inches
9. 6/16 inch - 3/8 inch
10. 3 inches

Assignment Sheet #2

1. a. 1 3/16 inches
   b. 6/16 = 3/8 inches
2. a. 4 6/16 inches = 4 3/8 inches
   b. 2 14/16 inches = 2 7/8 inches
3. a. 2 inches
   b. 2 inches
4. a. 1 3/16 inches
   b. 1 13/16 inches
   c. 3 8/16 = 3 1/2 inches
5. a. 2 9/16 inches
   b. 1 11/16 inches
6. a. 2 2/16 inches = 2 1/8 inches

b. 2 2/16 inches = 2 1/8 inches

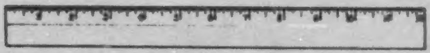
c. 2 10/16 inches = 2 5/8 inches

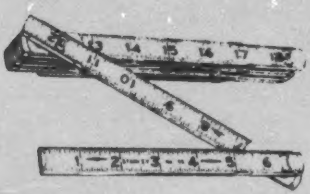
Assignment Sheet #3--Evaluated by instructor

BASIC MEASUREMENT
UNIT I

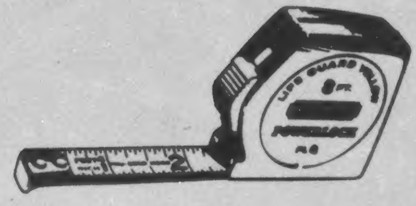
TEST

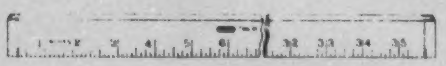
1. Identify five tools used in basic measuring.



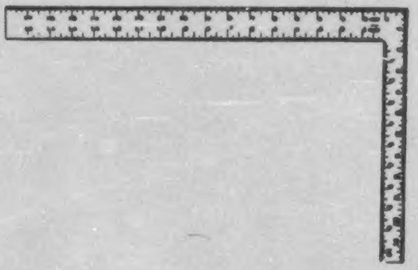


a. ______________________ b. ______________________



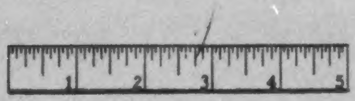


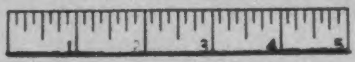
c. ______________________ d. ______________________



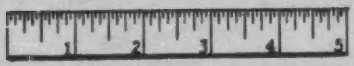
e. ______________________

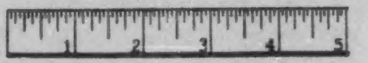
2. Classify the rules below as either 1/8 inch scale or 1/16 inch scale.





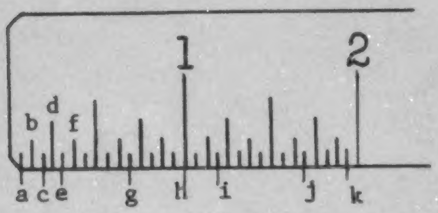
a. ____________ ____________ b. ____________ ____________





c. ____________ ____________ d. ____________ ____________

3. From the drawing below work the following problems.



a. What is the distance between A and I?____________

b. What is the distance between H and I?____________

c. What is the distance between A and F?____________

d. What is the distance between H and K?____________

e. What is the distance between A and K?____________

4. What is the length of the following lines?

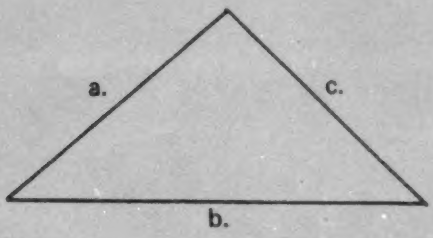
a. ________________________________

b. _______________________________

c. ____________________________________

d. ____

5. What are the dimensions of the following objects?



a. ____________

b. ____________

c. ____________

BASIC MEASUREMENT
UNIT I

ANSWERS TO TEST

1. a. Rule
   b. Zig-zag rule
   c. Steel tape
   d. Yard stick
   e. Steel framing square
2. a. 1/16 inch scale
   b. 1/8 inch scale
   c. 1/16 inch scale
   d. 1/16 inch scale
3. a. 1 3/8 inches
   b. 3/16 inch
   c. 5/16 inch
   d. 15/16 inch
   e. 1 15/16 inches
4. a. 2 5/16 inches
   b. 2 4/16 inches = 2 1/4 inches
   c. 2 12/16 inches = 2 3/4 inches
   d. 3 11/16 inches
5. a. 1 11/16 inches
   b. 2 7/16 inches
   c. 1 10/16 inches = 1 5/8 inches

BATTERY SERVICE
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to explain the function of a battery and define terms associated with battery testing. He should be able to remove and replace a battery with correct safety procedures. He should be able to clean, service, and check a battery. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Name three functions of a battery.
2. List three rules associated with battery safety.
3. Name four terms associated with battery construction.
4. Define terms associated with battery testing.
5. Demonstrate the ability to:
    a. Clean and service a battery.
    b. Remove and replace a battery.
    c. Check a battery with a hydrometer.
    d. Charge a battery.

BATTERY SERVICE
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparency.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in the job sheets.

  G. Give test.

II. Student:

  A. Read objectives.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency master: TM 1--Battery Construction

  D. Job sheets

    1. Job Sheet #1--Clean and Service a Battery

    2. Job Sheet #2--Remove and Replace a Battery

    3. Job Sheet #3--Check a Battery With a Hydrometer

    4. Job Sheet #4--Charge a Battery

E. Test

F. Answers to test

II. References:

A. *Fundamentals of Service Electrical Systems Manual.* Moline, Illinois: Deere and Company, 1968.

B. Billet, Walter E. and Leslie F. Goings. *Automotive Electrical Systems,* Third Edition. Chicago, Illinois: American Technical Society, 1970.

C. Crouse, William H. *Automotive Mechanics.* New York: Webster Division, McGraw-Hill Book Co., 1965.

D. *Tractor Maintenance: Principals and Procedures.* American Association for Vocational Instructional Materials.

BATTERY SERVICE
UNIT II

INFORMATION SHEET

I. Functions of a battery

   A. To supply current for starting the engine

   B. To supply current when the demand exceeds the output of the charging system

   C. To stabilize the voltage in the system during operation

II. Battery safety

   A. Battery electrolyte must not be allowed to spill or come in contact with clothing, skin, eyes, or car paint

   B. Flames or sparks must be kept away from a battery as the gases given off by a battery are very explosive

   C. Avoid shorting or grounding the battery during service or removal

III. Terms associated with battery construction

   A. Case--Holds the cells and electrolyte to make up the completed battery

   B. Vent caps--Provide a cell cover and allow gases to escape

   C. Positive post--Larger of the two battery posts

   D. Negative post--Smaller of the two battery posts

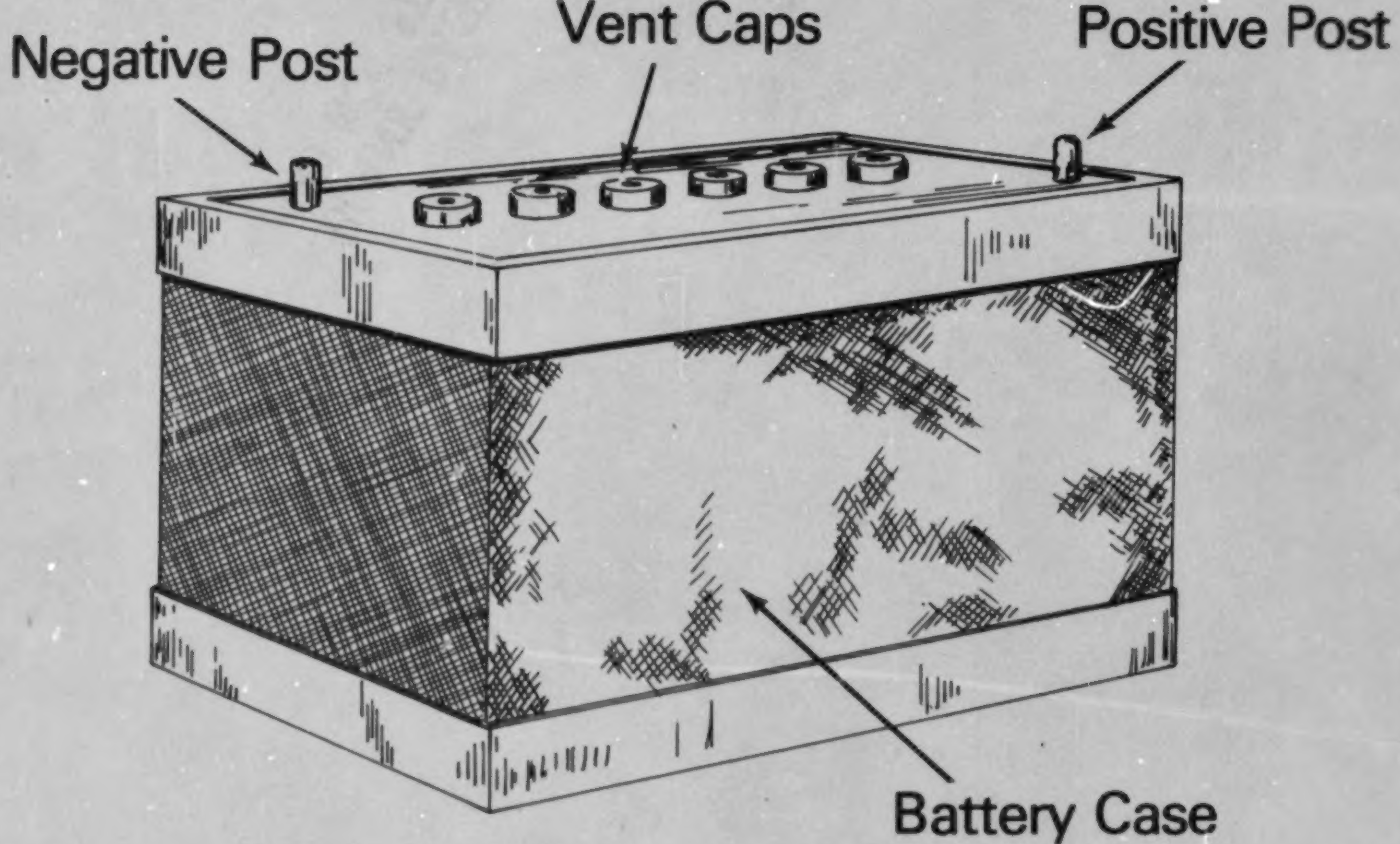
IV. Terms associated with battery testing

   A. Specific gravity--The weight of a solution compared to distilled water that has a reading of 1.000

   B. Hydrometer--An instrument which measures specific gravity of the electrolyte

   C. Electrolyte--Sulphuric Acid (H_2SO_4), the acid used in automotive wet cell batteries

Battery Construction


Negative Post
Vent Caps
Positive Post
Battery Case

TM 1

33-K

BATTERY SERVICE
UNIT II

JOB SHEET #1--CLEAN AND SERVICE A BATTERY

I. Tools and equipment needed

  A. Bristle brush

  B. Wire brush

  C. Screwdriver

  D. Battery clamp puller

  E. Combination end wrenches, 7/16" - 9/16"

  F. Baking soda and water solution (two tablespoons of baking soda to one pint of water)

  G. Battery anticorrosion paste

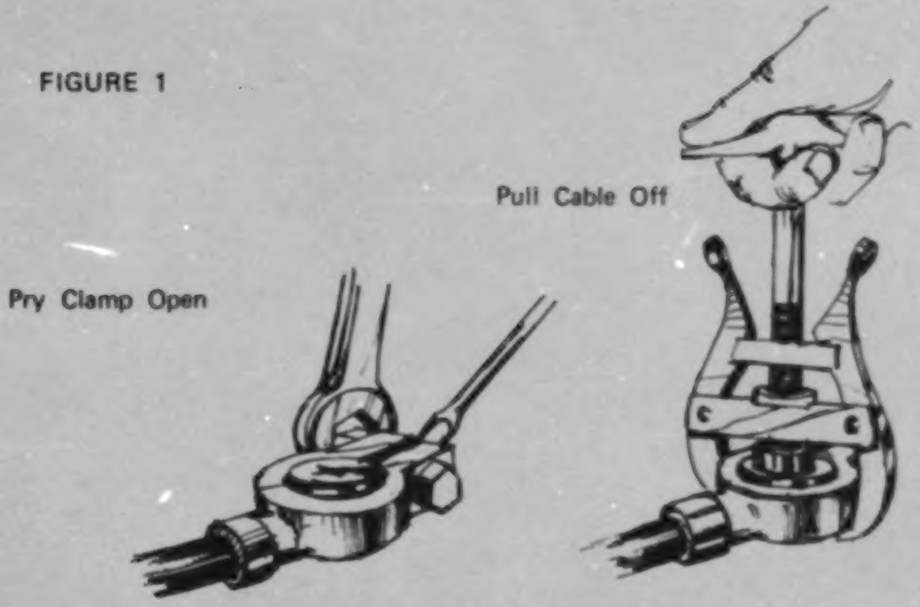
  H. Fender cover

II. Procedure

  A. Disconnect battery cables from the battery posts (Figure 1)

  (NOTE: Always disconnect the grounded battery cable first to avoid short circuits.)

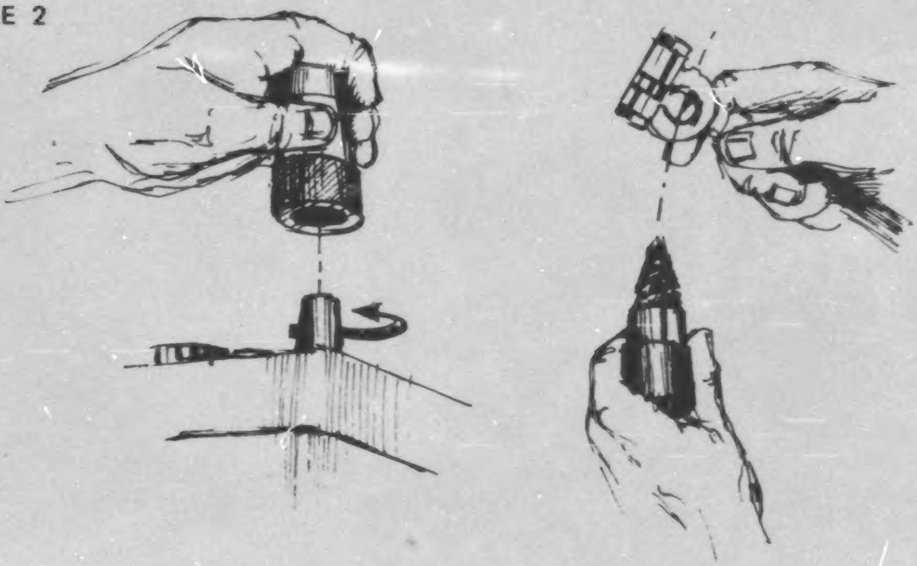
FIGURE 1



JOB SHEET #1

B. Clean battery cable clamps and battery posts (Figure 2)

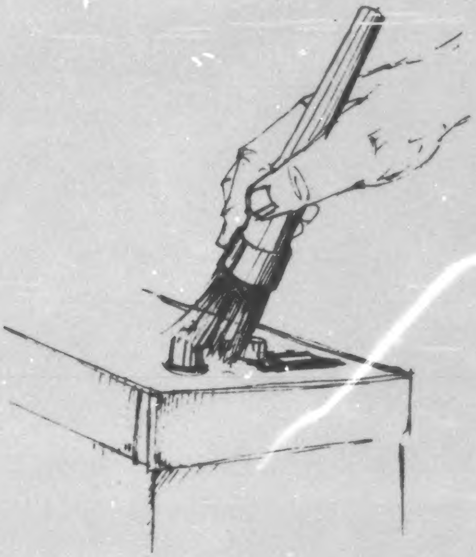
FIGURE 2



(NOTE: Battery posts and inside of battery cable clamps must be clean and bright.)

C. Remove loose dirt and corrosion particles from top of battery (Figure 3)

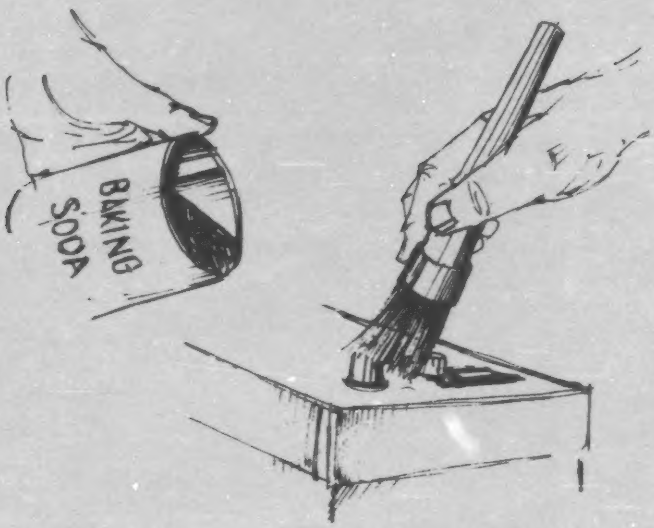
FIGURE 3



JOB SHEET #1

D. Brush soda water solution on battery, battery post, clamps, and battery hold-down (Figure 4)

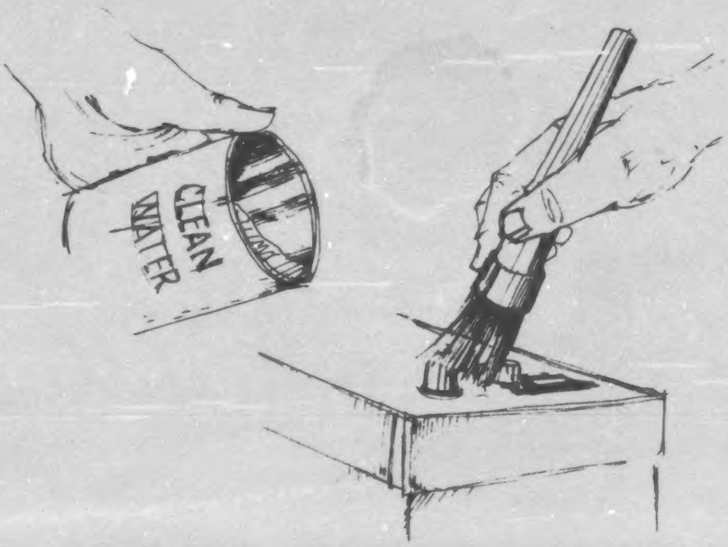
FIGURE 4



(NOTE: Keep water and soda from entering the battery through the vent holes in the vent caps.)

E. Wash away residue with clean water (Figure 5)

FIGURE 5



JOB SHEET #1

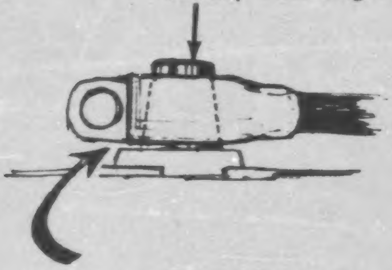
(NOTE: Remove all residue that may have lodged around battery, frame, or parts of the vehicle.)

(IMPORTANT: Battery acid will damage the car finish. Do not allow it to contact the finish surface.)

F. Dry the battery and battery cables with a clean cloth

G. Reconnect battery cables to the battery posts (Figure 6)

FIGURE 6



Battery Post Slightly Above Clamps

Correct Battery Cable Piston

(NOTE: Always reconnect the power cable first and the ground cable last.)

H. Spread a coating of battery anticorrosion paste over the cable clamps and terminals

I. Remove vent caps and check electrolyte level in all cells

J. Add water if necessary to bring electrolyte up to proper level

(NOTE: Do not overfill.)

BATTERY SERVICE
UNIT II

JOB SHEET #2--REMOVE AND REPLACE A BATTERY

I. Tools and equipment needed

   A. Wire brush

   B. Screwdriver

   C. Battery clamp puller

   D. Combination end wrenches, 7/16" - 9/16"

   E. Battery cable spreader

   F. Battery post and cable cleaner

   G. Fender cover

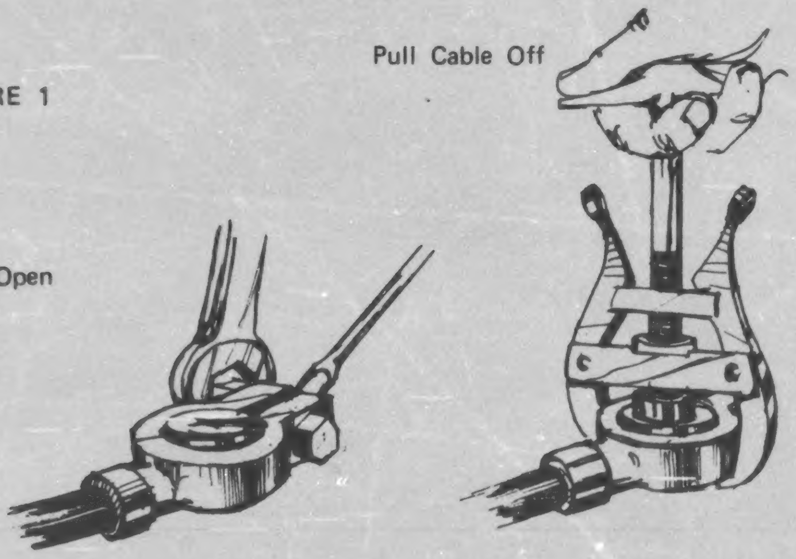
   H. Battery lift strap

II. Procedure

   A. Check carefully the location of the positive post so the battery can be installed in the same way

   B. Disconnect the battery cables from the battery posts (Figure 1)

FIGURE 1



(NOTE: Always disconnect the grounded battery cable first to avoid short circuits. Use care to avoid twisting the battery cable post.)

JOB SHEET #2

C. Remove the battery hold-down

D. Remove the battery from the vehicle

(NOTE: Use a suitable battery lift strap to lift the battery from the battery tray.)

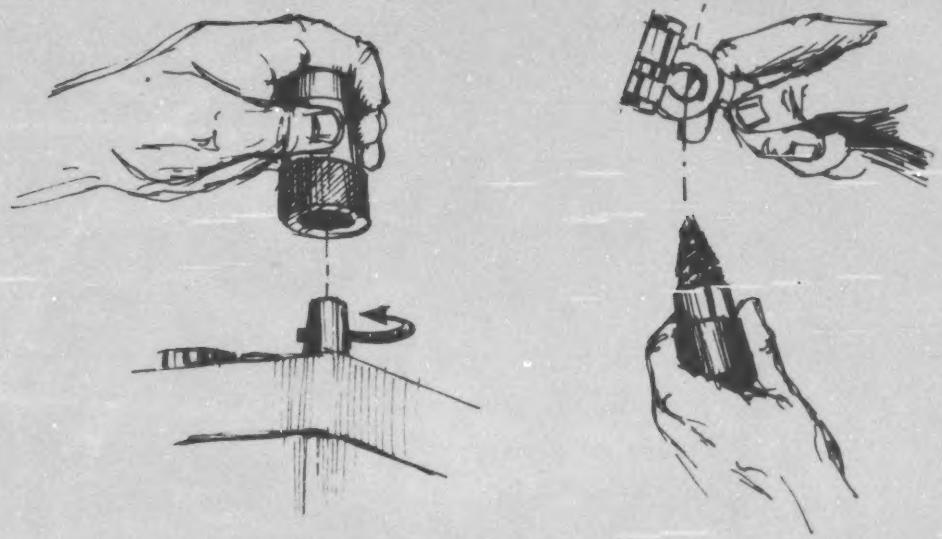
E. Inspect the battery tray for dirt or corrosion

(NOTE: Clean with baking soda and water as required.)

F. Check battery cables for worn or frayed insulation

G. Clean the inside of battery cables clean and bright (Figure 2)

FIGURE 2



H. Set the battery into place using a lift strap

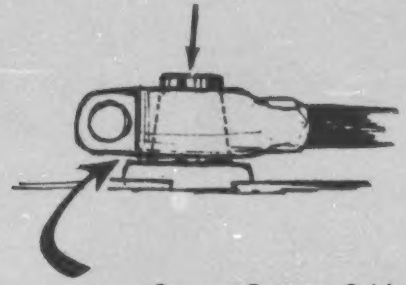
(NOTE: Position the battery to allow for correct battery cable attachment.)

I. Install the battery hold-down clamp or strap and tighten securely

JOB SHEET #2

J. Reconnect battery cables to the battery posts (Figure 3)

FIGURE 3


Battery Post Slightly Above Clamps
Correct Battery Cable Position

(NOTE: Always reconnect the power cable first and the ground cable last.)

K. Tighten the battery cable clamps securely

(NOTE: Use care to avoid twisting the battery cable post.)

L. Spread a coating of battery anticorrosion paste over the cable clamps and terminals

BATTERY SERVICE
UNIT II

JOB SHEET #3--CHECK A BATTERY WITH A HYDROMETER

I. Tools and equipment needed

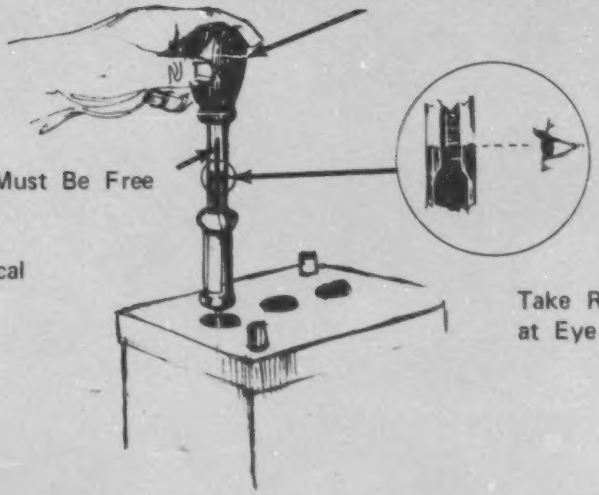
- A. Shop towels
- B. Hydrometer

II. Procedure

- A. Remove vent caps from battery
- B. Insert the hydrometer into the first cell
- C. Squeeze the rubber bulb to draw electrolyte into the hydrometer to suspend the float

  (NOTE: If the electrolyte level is too low, add water, charge for one hour, and recheck.)
- D. Make sure the float is not bumping the top of the hydrometer tube or sticking to the side of the tube
- E. Take reading at eye level (Figure 1)

FIGURE 1


Do Not Suck in Too Much Electrolyte
Float Must Be Free
Hold Tube Vertical
Take Reading at Eye Level

(NOTE: Write down reading for each cell.)

JOB SHEET #3

F. Squeeze bulb to return electrolyte to cell

G. Repeat for other cells

H. Adjust the readings for temperature

(NOTE: Add four gravity points (0.004) to the reading for every 10° F. above 80°. Subtract four gravity points (0.004) for each 10° below 80° F.)

I. Specific gravity should read from 1.215 to 1.270 (corrected for 80° F. electrolyte temperature)

J. The variation in readings between cells should be no more than 0.050

K. If the readings are not within the above mentioned range, further testing will be required

L. Replace vent caps upon completion of test

BATTERY SERVICE
UNIT II

JOB SHEET #4--CHARGE A BATTERY

I. Tools and equipment needed

   A. Bristle brush

   B. Wire brush

   C. Screwdriver

   D. Battery clamp pulley

   E. Combination end wrenches 7/16 - 9/16

   F. Baking soda and water solution

   G. Battery anticorrosion paste

   H. Fender cover

   I. Hydrometer

   J. Shop towels

   K. Battery charger

II. Procedure

   A. Check battery with a hydrometer (Job Sheet #3)

   B. Clear and service battery (Job Sheet #1)

   C. Check alternator belts (See manufacturer's specifications.)

   D. Charge battery

      1. Connect charger cables to battery

         a. Red + to the positive + post

         b. Black - to the negative - post

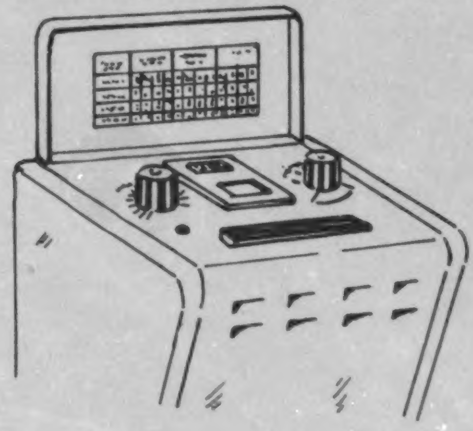
   (CAUTION: Connecting a battery backward could result in an explosion. Be sure you hook up cables right.)

   (NOTE: Twist the cable clamps to be sure you have a good connection.)

JOB SHEET #4

2. Set time control and charging to off positions
3. Plug in A.C. cord to power source
4. Set time control to number of minutes (Figure 1)

FIGURE 1



5. Advance charging control until meter registers at or slightly below the maximum charge rate; set control for 6 volt, 8 volt, or 12 volt.

   (NOTE: See Figure 1.)

6. Disconnect A.C. plug from power source.
7. Disconnect cables from battery
8. Turn all control settings to off position
9. Add electrolyte to battery if needed

   (IMPORTANT: Do not allow electrolyte to get on painted surface or damage to the paint will result.)

BATTERY SERVICE
UNIT II

TEST

1. Name three functions of a battery.

   a.

   b.

   c.

2. List three rules associated with battery safety.

   a.

   b.

   c.

3. Name four terms associated with battery construction.

   a.

   b.

   c.

   d.

4. Define terms associated with battery testing.

   a. Specific gravity--

   b. Hydrometer--

   c. Electrolyte--

5. Demonstrate the ability to:

   a. Clean and service a battery.

   b. Remove and replace a battery.

   c. Check a battery with a hydrometer.

   d. Charge a battery.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

BATTERY SERVICE
UNIT II

ANSWERS TO TEST

1. a. To supply current for starting the engine

   b. To supply current when the demand exceeds the output of the charging system

   c. To stabilize the voltage in the system during operation

2. a. Battery electrolyte must not be allowed to spill or come in contact with clothing, skin, eyes, or car paint

   b. Flames or sparks must be kept away from a battery as the gases given off by a battery are very explosive

   c. Avoid shorting or grounding the battery during service or removal

3. a. Case

   b. Vent caps

   c. Positive post

   d. Negative post

4. a. Specific gravity--The weight of a solution compared to distilled water that has a reading of 1.000

   b. Hydrometer--An instrument which measures specific gravity of electrolyte

   c. Electrolyte--Sulfuric Acid (H_2SO_4), the acid used in automotive wet cell batteries

5. Performance skills will be evaluated according to the criteria listed on the progress chart.

CIRCUITS AND WIRES
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms associated with circuits and wires, identify symbols and types of automotive bulbs and sealed beams. He should be able to install terminals, splice wire, replace bulbs, replace sealed beam headlights, and align them and replace or repair power window motors. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the terms associated with circuits and wires to definitions.
2. Identify the symbols used for electrical components.
3. Identify the three types of circuits.
4. Match a list of terminals to illustrations.
5. Name the two common types of bulbs used in automobiles.
6. Name two types of splices.
7. Name the two sealed beams used in a dual lamp set up.
8. Demonstrate the ability to:
    a. Install a soldered terminal.
    b. Install a solderless terminal.
    c. Splice a wire (solder).
    d. Splice a wire (solderless).
    e. Remove and replace a bulb.
    f. Remove and replace a sealed beam.
    g. Align headlights.
    h. Remove, clean, and replace a power window motor.

CIRCUITS AND WIRES
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in job sheets.
- G. Give test.

II. Students:

- A. Read objective sheet.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency masters
  - 1. TM 1--Electric Symbols
  - 2. TM 2--Electric Circuits
  - 3. TM 3--Electric Circuits (Continued)
  - 4. TM 4--Circuit Problems

   5. TM 5--Circuit Breaker
   6. TM 6--Terminals
   7. TM 7--Lamps
   8. TM 8--Sealed Beam Lamp
   9. TM 9--Fuse and Switch

D. Job sheets

   1. Job Sheet #1--Install a Soldered Terminal
   2. Job Sheet #2--Install a Solderless Terminal
   3. Job Sheet #3--Splice a Wire (Solder)
   4. Job Sheet #4--Splice a Wire (Solderless)
   5. Job Sheet #5--Remove and Replace a Bulb
   6. Job Sheet #6--Remove and Replace a Sealed Beam
   7. Job Sheet #7--Align Headlights
   8. Job Sheet #8--Remove, Clean, and Replace a Power Window Motor

II. References:

A. Hobson, W. T. *Automotive Refinishing Principles and Techniques.* First Edition. Wilmington, Delaware: E. T. duPont de Nemours and Co., 1969.

B. Hogg, John W. *Auto Body Repair and Refinishing.* Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.

C. MacPherson, Robert C. *Collision Repair Guide.* New York: McGraw-Hill Inc., 1971.

D. Spicer, Edward D. *Automotive Collision Work.* Fourth Edition. Chicago, Illinois: American Technical Society, 1972.

E. Toboldt, Bill. *Auto Body Repair and Refinishing.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

CIRCUITS AND WIRES
UNIT III

INFORMATION SHEET

I. Terms and definitions (Transparencies 1, 2, 3, 4, 5, 6, 7, 8, and 9)

A. Voltage--Unit of measure of the electrical pressure in a circuit as measured with a voltmeter

B. Amperage--Unit of measurement of the amount of current passing a given point each second

(NOTE: Any ampmeter will measure the amperage and show the direction of flow.)

C. Resistance--An ohm is the unit of measurement of the resistance in a circuit opposing a flow of one ampere moved by a pressure of one volt

D. Conductor--Carries the electric current from the source to the load and back to the source

E. Insulator--Prevents electric current from leaking (shorting) to another conductor

F. Alternating current (AC)--Electric current that flows first in one direction through the circuit, then reverses and flows in the opposite direction

G. Direct current (DC)--Electric current that flows in one direction through the circuit

H. Circuit--Electricity travels through a conductor to the work load and back through a conductor to the source completing the circuit

I. Series circuit--Electricity has only one path through which to travel

J. Parallel circuit--Electricity has two or more paths through which to travel

K. Series-Parallel circuit--Combination of series and parallel circuits

L. Open circuit--Occurs when a conductor (wire) is broken or connections are poor and current is unable to flow

M. Short circuit--Occurs when two or more wires touch each other; the current takes the path of least resistance and an excessively large amount of current flows under these conditions

N. Primary wire--Low tension wire used for low voltage ignition, lighting, and accessory circuits

(NOTE: The primary wire is measured in "gauge." The higher the number the smaller the wire.)

INFORMATION SHEET

O. Secondary wire--High tension wire used for high voltage ignition circuits as in spark plugs and coil wires

P. Terminal--Connecting device used to attach the wires (circuits) to the different electrical components

Q. Circuit breaker--A mechanical device activated by heat; when the amperage exceeds the device's safety rating, a set of contact points open stopping the flow of current

R. Fuse--Constructed of a glass tube and a thin metal strip; when too much current passes through the fuse, the strip will melt stopping the flow of current

S. Switch--Placed in a series with the circuit, it makes or breaks the circuit

T. Bulb--A device for lighting a given area

(NOTE: Bulbs are rated by the candle power produced by a given voltage. All bulbs are identified by a number which classifies it by candle power and amperage.)

U. Filament--Fine coiled tungsten wires which are vacuum sealed in a glass chamber

(NOTE: When heated, the filament glows producing light.)

V. Single filament--A bulb with only one filament

W. Double filament--A bulb with two filaments

X. Wiring harness--Any system of wires which are taped together for electric distribution throughout the automobile

Y. Short--Unintentional ground caused by failure of the system due to an accident or wear

II. Electrical symbols (Transparency 1)

A. 12V battery

B. Ammeter

C. Voltmeter

D. Circuit breaker

E. Fuse

INFORMATION SHEET

- F. Coil
- G. Single-filament lamp
- H. Double-filament lamp
- I. Connected conductors
- J. Cross-over conductors

III. Types of circuits (Transparencies 2, 3, 4, and 5)

- A. Series
- B. Parallel
- C. Series-Parallel

IV. Terminals (Transparency 6)

- A. Ring
- B. Spade
- C. Roll
- D. Male
  - 1. Bullet
  - 2. Tab
- E. Female
  - 1. Bullet
  - 2. Tab

V. Types of bulbs used in automobiles (Transparency 7)

- A. Single filament
- B. Double filament

VI. Types of splices

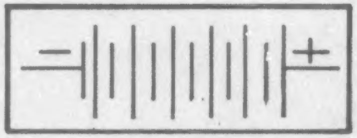
- A. Solder
- B. Solderless

INFORMATION SHEET

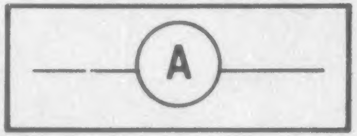
VII. Sealed beams used in a dual lamp set up (Transparency 8)

- A. Single filament--High beam
- B. Double filament--Low-high beam

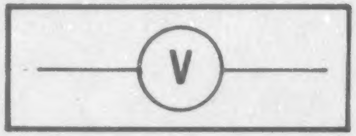
Electric Symbols



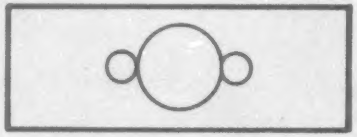
12V Battery



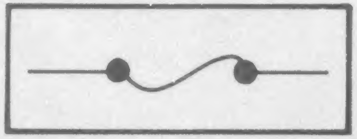
Ammeter



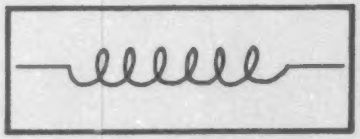
Voltmeter



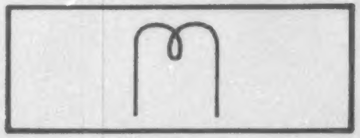
Circuit Breaker



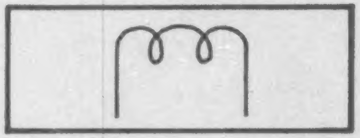
Fuse



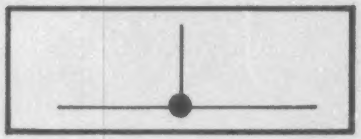
Coil



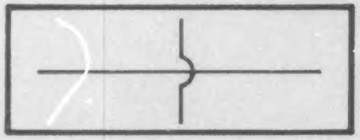
Single-Filament
Lamp



Double-Filament
Lamp

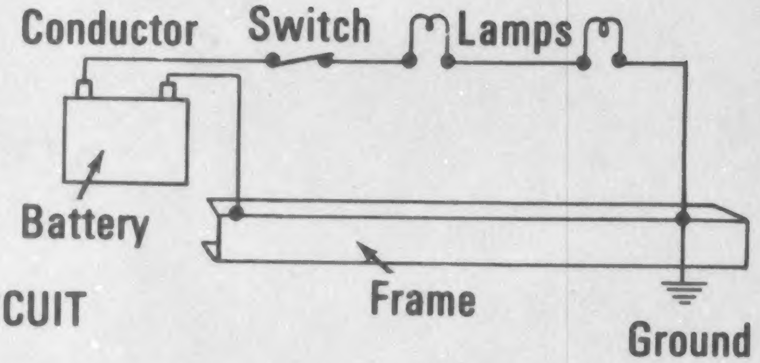


Connected
Conductors

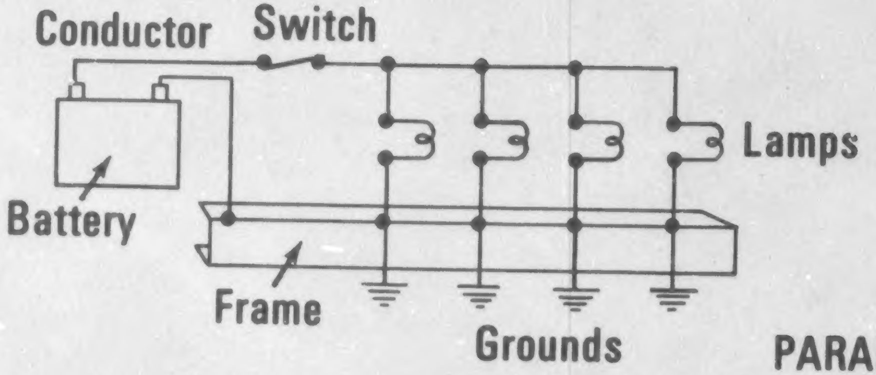


Cross-Over
Conductors

Electric Circuits


Conductor
Switch
Lamps
Battery
Frame
Ground

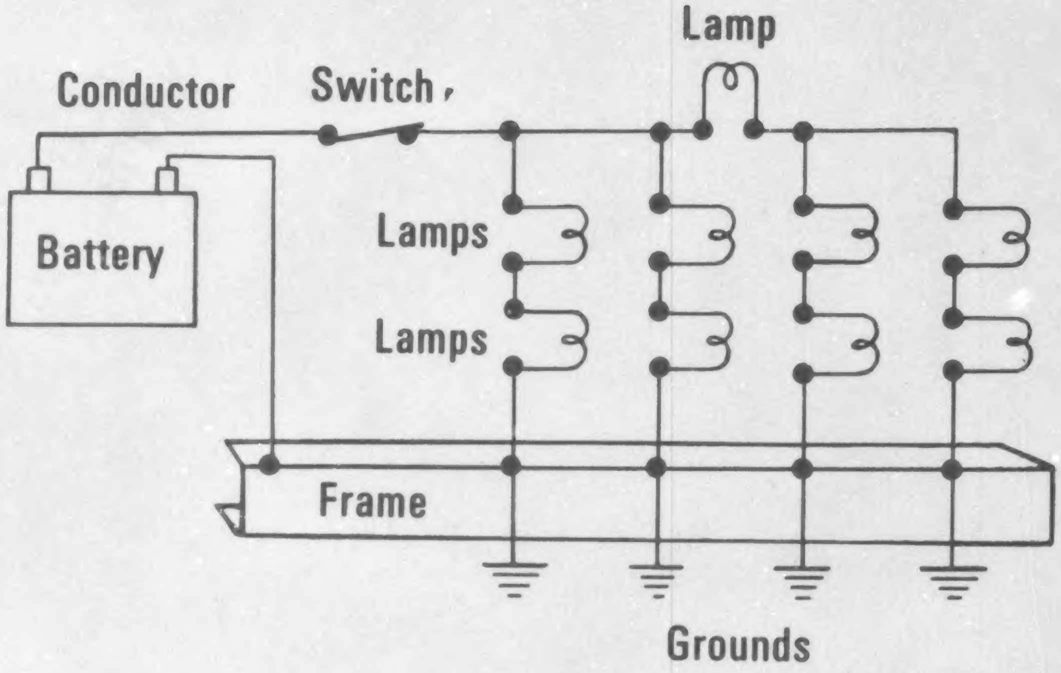
SERIES CIRCUIT


Conductor
Switch
Lamps
Battery
Frame
Grounds

PARALLEL CIRCUIT

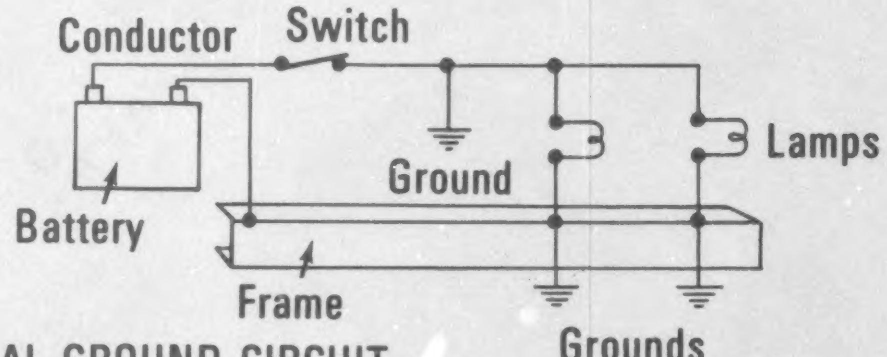
Electric Circuits

(CONTINUED)

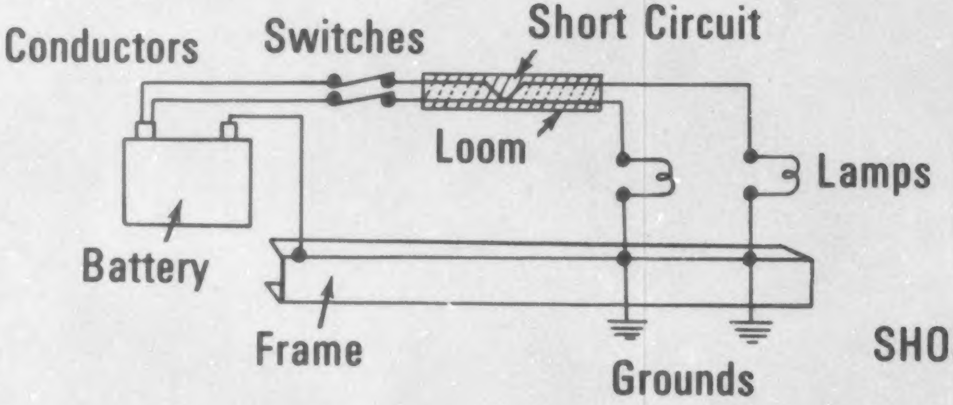

Lamp
Conductor
Switch
Battery
Lamps
Lamps
Frame
Grounds

SERIES-PARALLEL CIRCUIT

Circuit Problems

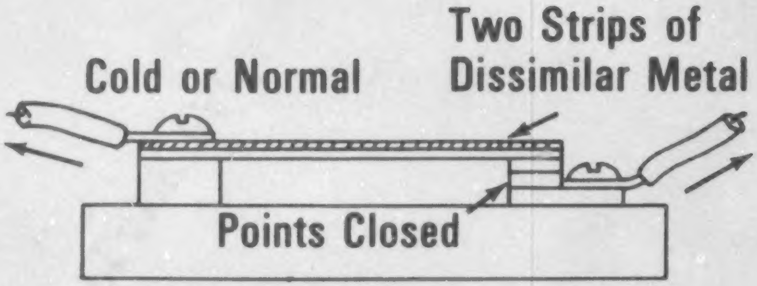

Conductor
Switch
Ground
Lamps
Battery
Frame
Grounds

UNINTENTIONAL GROUND CIRCUIT

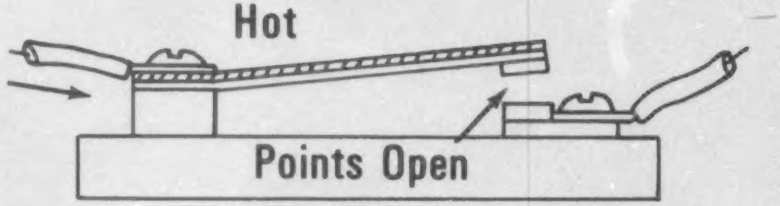

Conductors
Switches
Short Circuit
Loom
Lamps
Battery
Frame
Grounds

SHORT CIRCUIT

Circuit Breaker

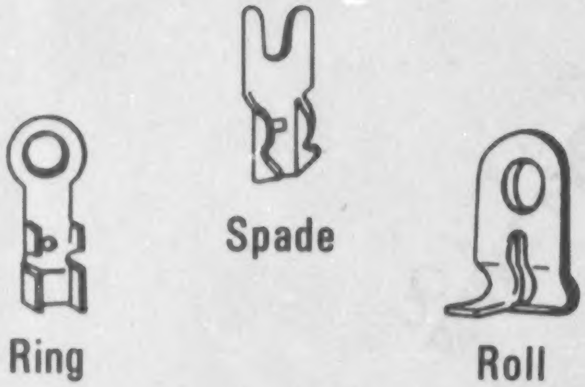

Cold or Normal
Two Strips of Dissimilar Metal
Points Closed

Breaker is carrying a normal load. Contact points are closed and the circuit is complete.

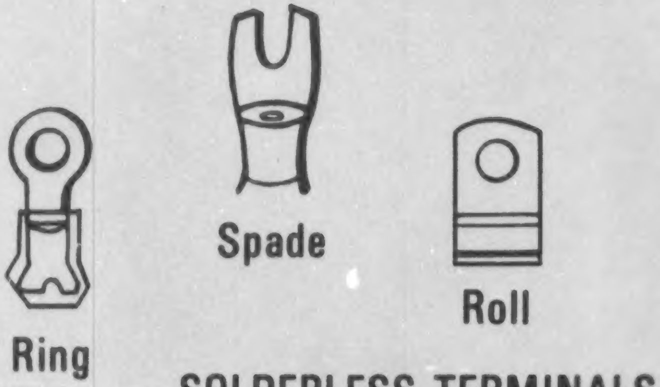

Hot
Points Open

Breaker overloaded, causing the bi-metallic strip to heat up. Strip curves upward separating the points, and the circuit is broken.

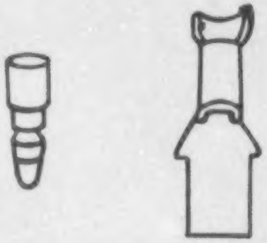
Terminals


Ring
Spade
Roll

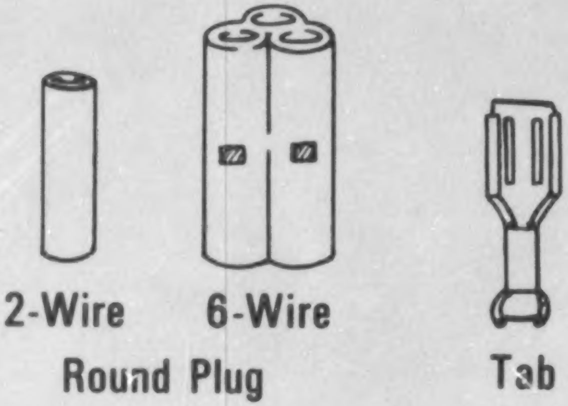
SOLDER-TYPE TERMINALS


Ring
Spade
Roll

SOLDERLESS TERMINALS



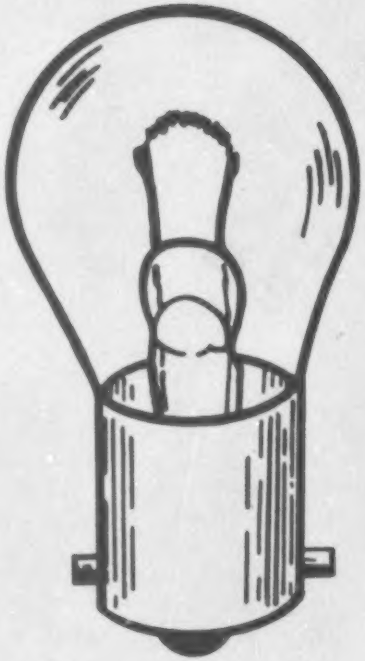
MALE TERMINALS


2-Wire
6-Wire
Round Plug
Tab

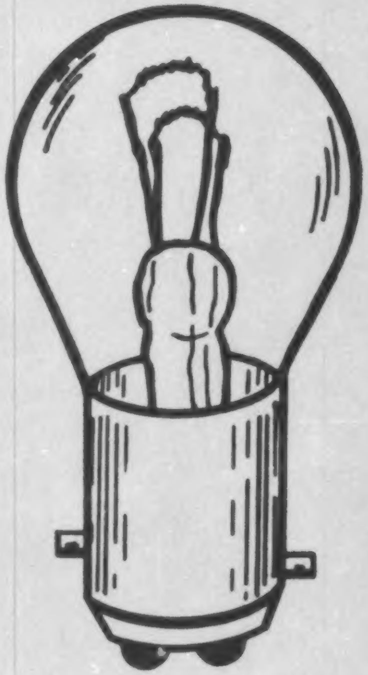
FEMALE CONNECTORS

SOLDERLESS, SNAP-FAST TERMINALS and CONNECTORS

Lamps

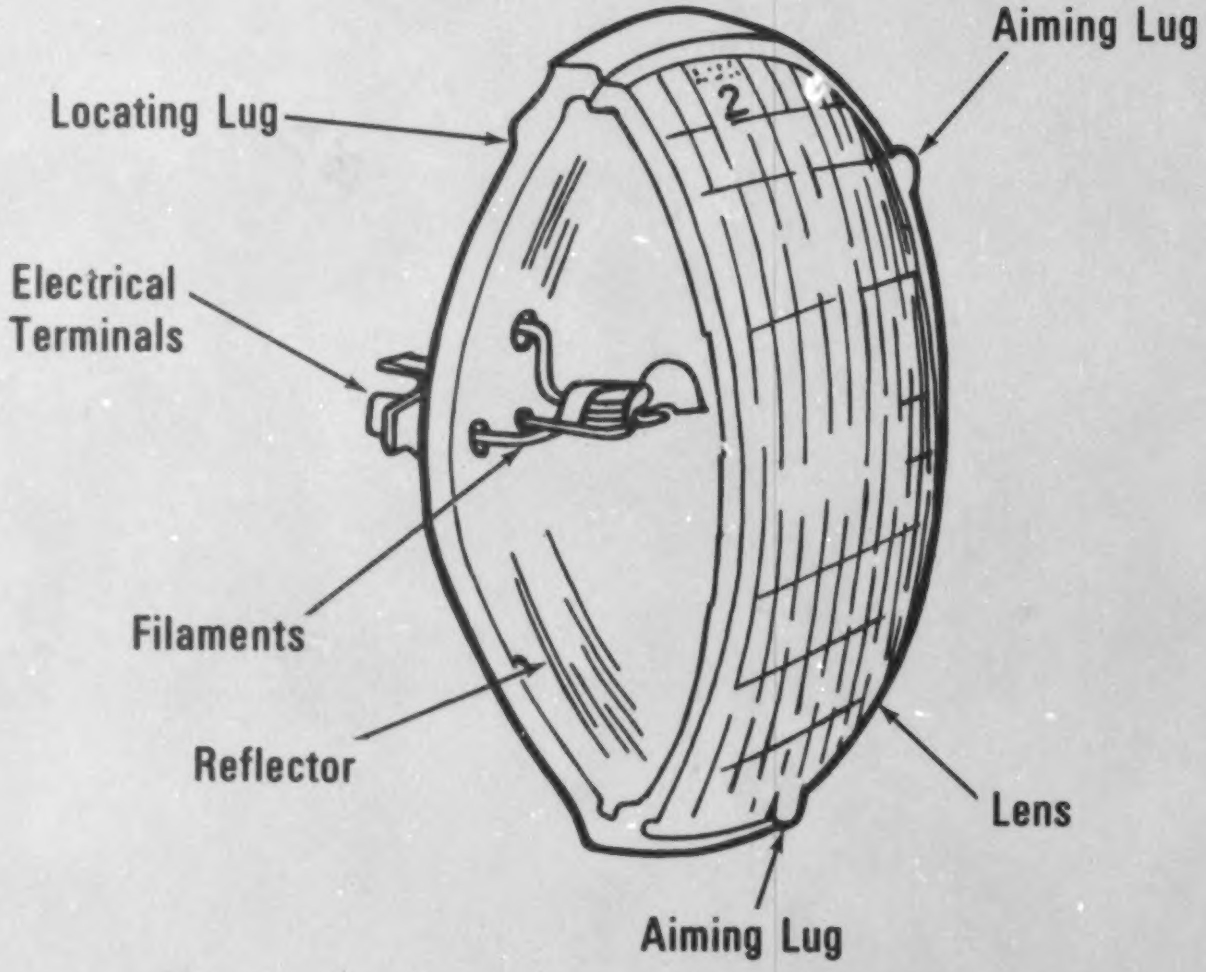


SINGLE-FILAMENT LAMP

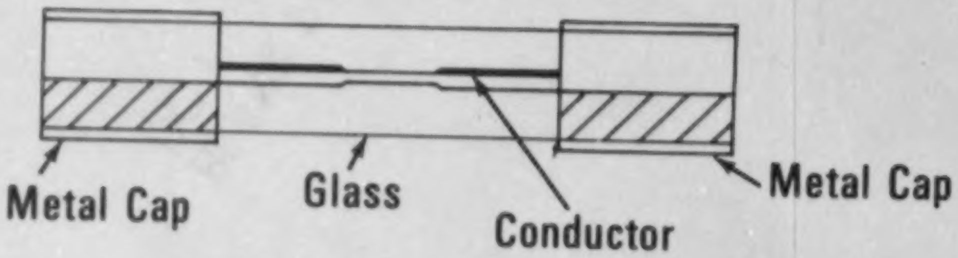


DOUBLE-FILAMENT LAMP

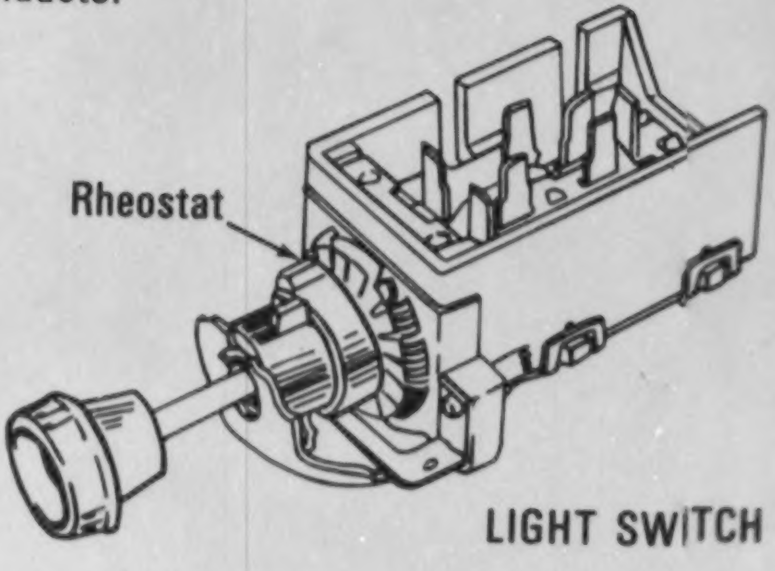
Sealed Beam Lamp


Aiming Lug
Locating Lug
Electrical Terminals
Filaments
Reflector
Lens
Aiming Lug

Fuse and Switch


Metal Cap
Glass
Conductor
Metal Cap

COMMON FUSE



LIGHT SWITCH

CIRCUITS AND WIRES
UNIT III

JOB SHEET #1--INSTALL A SOLDERED TERMINAL

I. Tools and equipment needed

   A. Soldering gun or iron

   B. Resin core solder

   C. Medium sandpaper

   D. Terminal

   E. Electrical wire

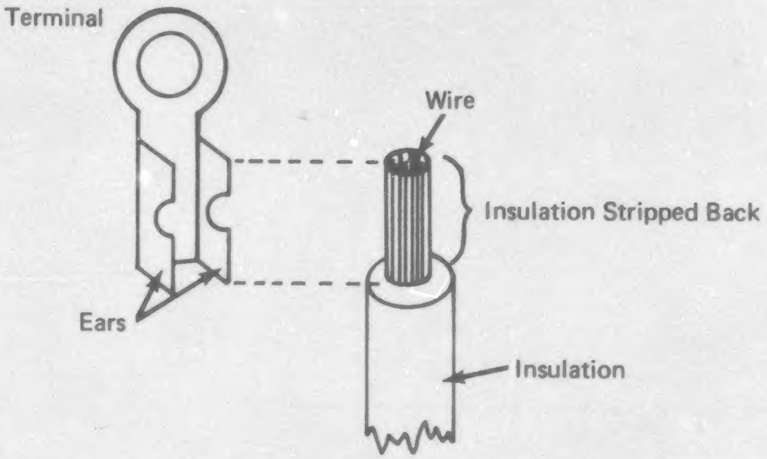
   F. Electrical tape

II. Procedure

   A. Strip end of insulation back from wire to permit installation of terminal (Figure 1)

   (NOTE: Always use the same size wire as orginally used by the manufacturer.)

FIGURE 1

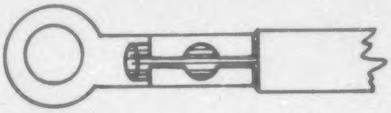

Terminal
Wire
Insulation Stripped Back
Ears
Insulation

JOB SHEET #1

B. Clean terminal with sandpaper

C. Place wire in terminal and bend ears of terminal around wire (Figure 2)

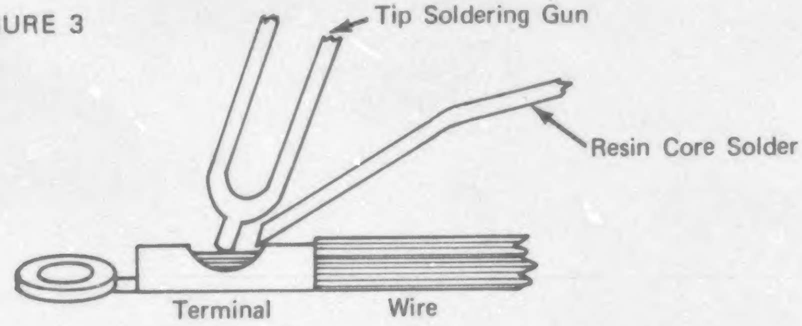
FIGURE 2



D. Solder terminal to wire (Figure 3)

(IMPORTANT: Use resin core solder only on electrical connections.)

FIGURE 3

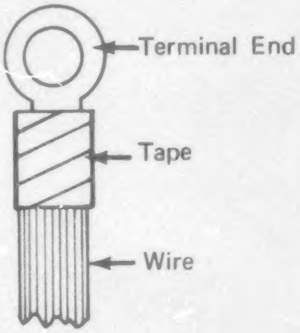

Tip Soldering Gun
Resin Core Solder
Terminal
Wire

(NOTE: Apply only enough solder to attach terminal.)

F. Tape connection (Figure 4)

(NOTE: Only necessary if solder crimp area will contact or ground against a metal area.)

FIGURE 4


Terminal End
Tape
Wire

CIRCUITS AND WIRES
UNIT III

JOB SHEET #2--INSTALL A SOLDERLESS TERMINAL

I. Tools and equipment needed

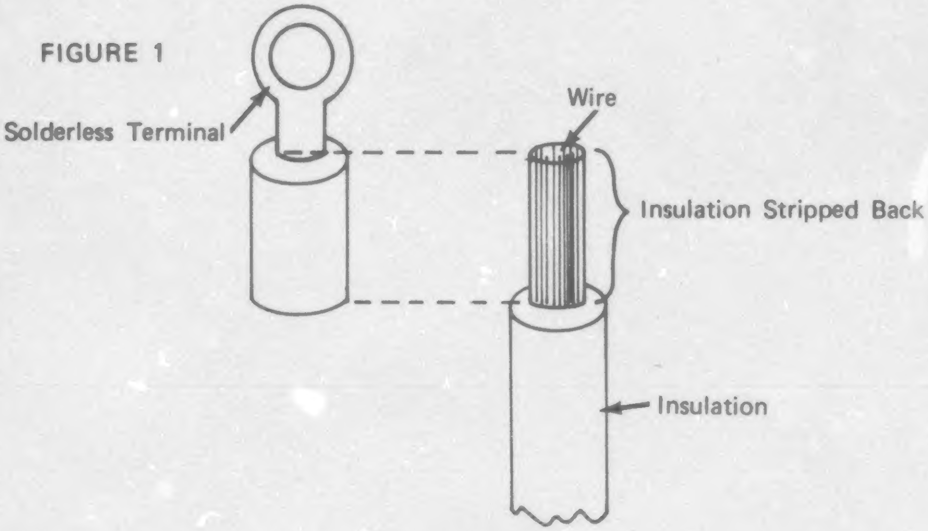
   A. Crimping pliers

   B. Terminal

II. Procedure

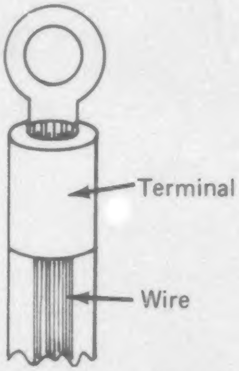
   A. Strip insulation from wire to fit terminal (Figure 1)

FIGURE 1


Solderless Terminal
Wire
Insulation Stripped Back
Insulation

   B. Insert wire into terminal (Figure 2)

FIGURE 2

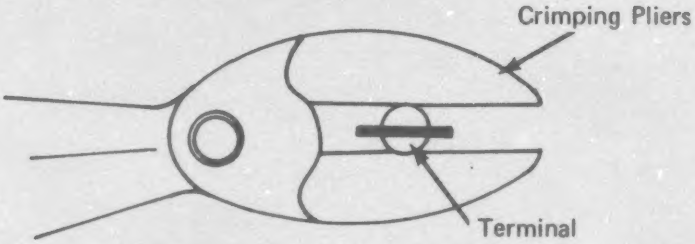

Terminal
Wire

(NOTE: Always use the terminal that fits the wire properly.)

JOB SHEET #2

C. Crimp the terminal to the wire (Figure 3)

FIGURE 3



(NOTE: Use the correct crimper opening when crimping the terminal to the wire.)

D. Connect terminal and wire to power source

(NOTE: Always use the proper size wire when making a repair as required by the manufacturer.)

CIRCUITS AND WIRES
UNIT III

JOB SHEET #3--SPLICE A WIRE (SOLDER)

I. Tools and equipment needed

   A. Soldering gun or iron

   B. Electrical wire

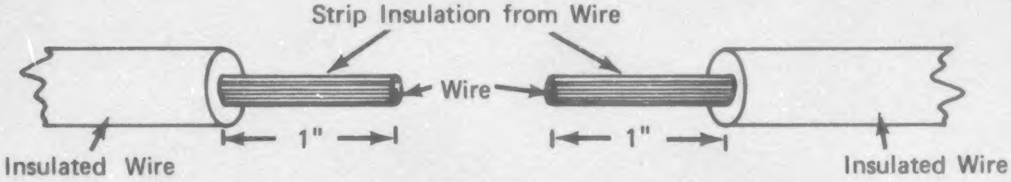
   C. Resin core solder

   D. Electrical tape

II. Procedure

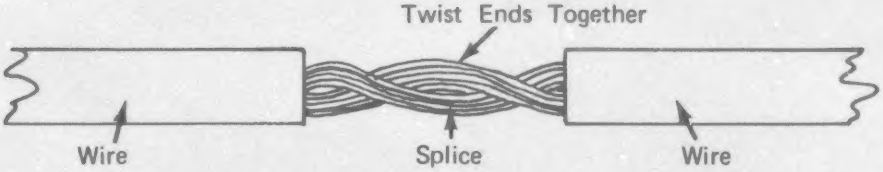
   A. Strip back insulation from ends of wire one inch (Figure 1)

FIGURE 1


Strip Insulation from Wire
Wire
1"
1"
Insulated Wire
Insulated Wire

   B. Twist wire ends together (Figure 2)

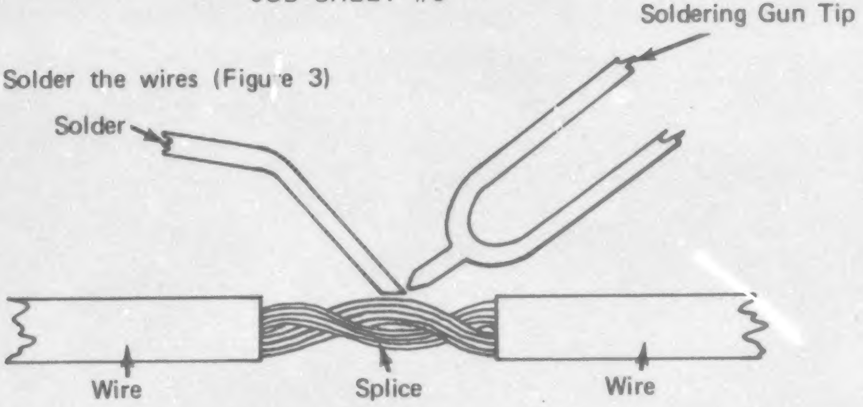
FIGURE 2


Twist Ends Together
Wire
Splice
Wire

JOB SHEET #3

C. Solder the wires (Figure 3)

FIGURE 3


Soldering Gun Tip
Solder
Wire
Splice
Wire

(NOTE: Only flow enough solder on splice to hold wire securely. Do not waste solder or build up joint. If splice has too much solder, the splice joint will break.)

D. Tape splice--Wrap with electrical tape

(NOTE: Tape splice neatly.)

CIRCUITS AND WIRES
UNIT III

JOB SHEET #4--SPLICE A WIRE (SOLDERLESS)

I. Tools and equipment needed

   A. Electrical wire

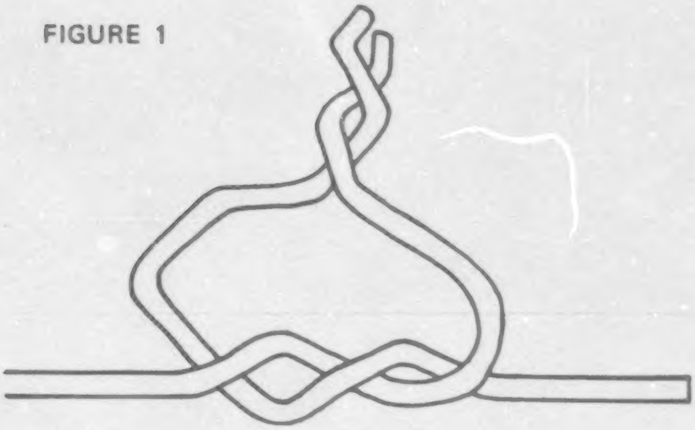
   B. Electrical tape

II. Procedure

   A. Strip back insulation from ends of wire one inch

   B. Tie wire and twist ends together (Figure 1)

FIGURE 1



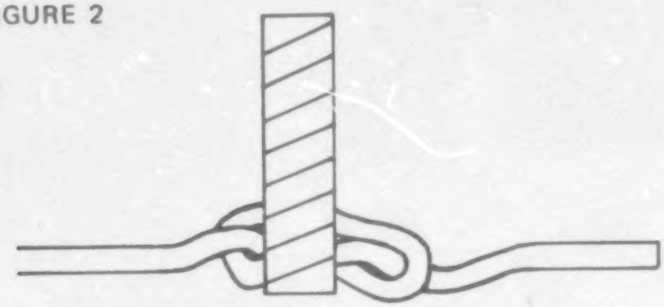
   C. Pull knot tight

JOB SHEET #4

D. Tape splice ends of wire

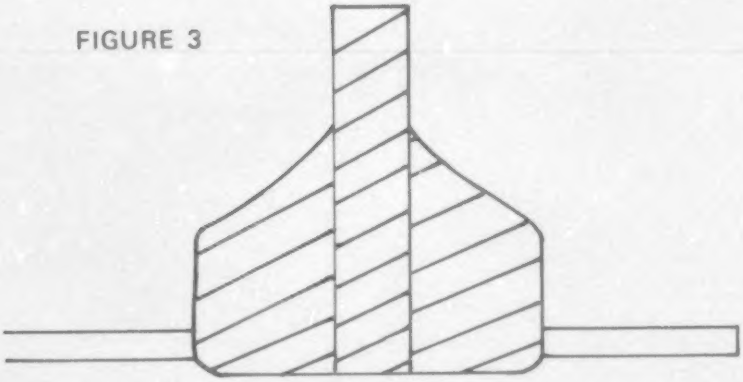
1. Tape splice end in long direction (Figure 2)

FIGURE 2



2. Wrap splice with tape (Figure 3)

FIGURE 3



(NOTE: By tieing in a knot the splice cannot pull apart. Be sure to tape securely, because if the elements can get to the wire splice and corrode the wires, an open circuit could result at the splice.)

CIRCUITS AND WIRES
UNIT III

JOB SHEET #5--REMOVE AND REPLACE A BULB

I. Tools and equipment needed

  A. Bulb pliers

  B. Straight blade screwdriver set

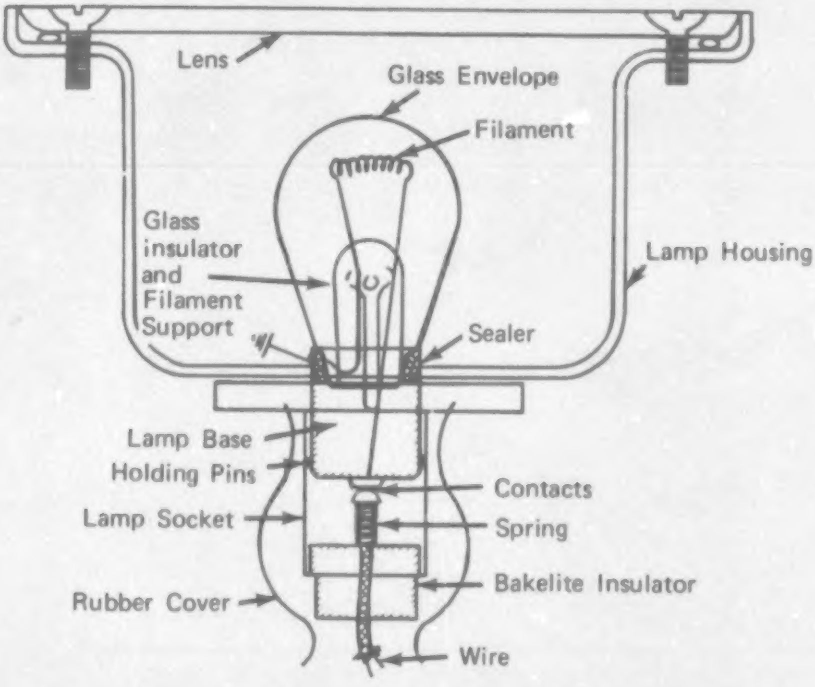
  C. Phillips blade screwdriver set

II. Procedure

  A. Remove lens, door, or cover from light assembly (Figure 1)

  (NOTE: Dash (interior) light assemblies twist or pull out.)

FIGURE 1


Lens
Glass Envelope
Filament
Glass insulator and Filament Support
Lamp Housing
Sealer
Lamp Base
Holding Pins
Contacts
Lamp Socket
Spring
Bakelite Insulator
Rubber Cover
Wire

JOB SHEET #5

B. Remove bulb

  1. Push in on bulb
  2. Twist counterclockwise
  3. Pull bulb out of socket

C. Clean socket

  1. Sandpaper
  2. Scuff pad
  3. Blow socket out with air

D. Replace bulb

  1. Push bulb in socket
  2. Turn clockwise to lock

  (NOTE: Not all bulbs are retained in this type of socket. Side marker lights just push in and pull out, and some dome and interior lights are retained by clips. Examine each light carefully. Always replace bulbs with the same number as the original.)

E. Replace lens

  1. Clean and install gasket if used
  2. Clean lens
  3. Assemble lens on light assembly

CIRCUITS AND WIRES
UNIT III

JOB SHEET #6--REMOVE AND REPLACE A SEALED BEAM

I. Tools and equipment needed

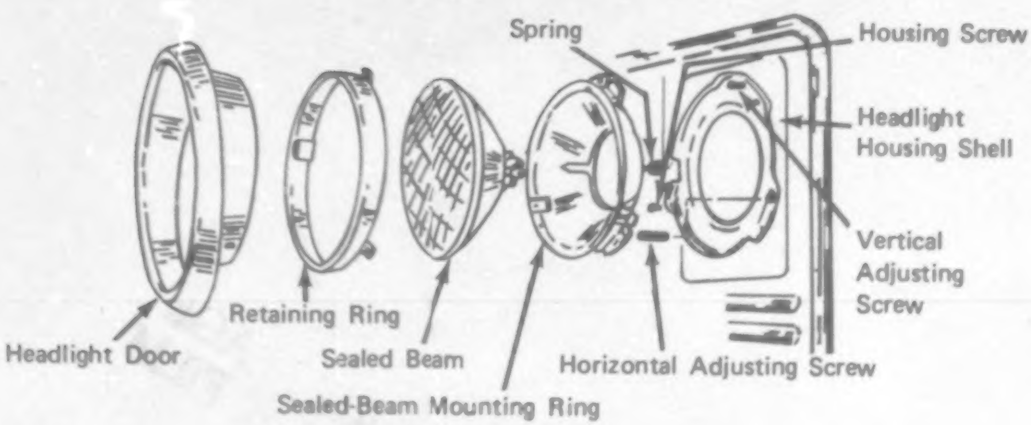
   A. Straight blade screwdriver set

   B. Phillips screwdriver set

II. Procedure

   A. Remove headlight door, retaining ring, and sealed beam (Figure 1)

FIGURE 1


Spring
Housing Screw
Headlight Housing Shell
Vertical Adjusting Screw
Retaining Ring
Headlight Door
Sealed Beam
Horizontal Adjusting Screw
Sealed-Beam Mounting Ring

   B. Replace sealed beam

   C. Replace retaining ring

   (NOTE: On some models the spring from the headlight housing to the headlight bucket must be attached before screws are installed. Do not stretch the spring.)

   D. Align headlights (See Job Sheet #7)

   (NOTE: On some models, the headlight can be adjusted with the headlight door attached.)

   E. Replace headlight door

CIRCUITS AND WIRES
UNIT III

JOB SHEET #7--ALIGN HEADLIGHTS

I. Tools and equipment needed

   A. Headlight aligner

   B. Phillips screwdriver set

   C. Straight blade screwdriver set

II. Procedure

   A. Attach or set up headlight alignment equipment

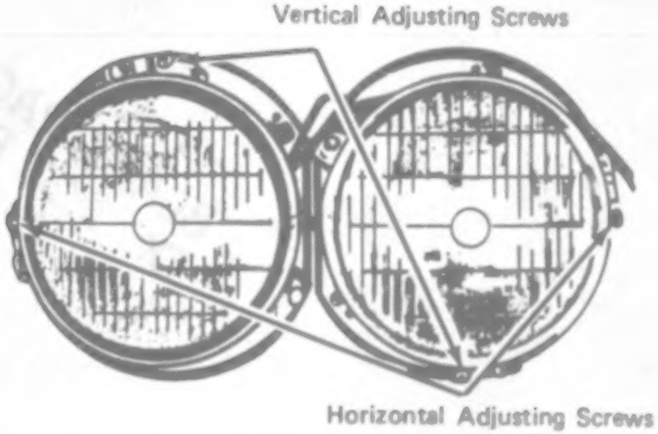
   (IMPORTANT: Read manufacturer's directions carefully and install or set up alignment equipment properly.)

   B. Adjust headlight (Figure 1)

      1. Adjust vertical adjusting screws

      2. Adjust horizontal adjusting screws

FIGURE 1


Vertical Adjusting Screws
Horizontal Adjusting Screws

CIRCUITS AND WIRES
UNIT III

JOB SHEET #8--REMOVE, CLEAN, AND REPLACE A POWER WINDOW MOTOR

I. Tools and equipment needed

- A. Phillips screwdriver set
- B. Straight blade screwdriver set
- C. 1/4" drive ratchet and socket set
- D. 1/4"-5/8" end wrench set
- E. Hex wrench set

II. Procedure

A. Remove trim panel (See Interior Trim, Unit II, Job Sheet #4)

B. Remove window regulator (See Hardware, Unit III, Job Sheet #2)

(NOTE: See special caution on regulator removal in Unit II, Job Sheet #2)

C. Turn regulator manually to where spring tension is released

(CAUTION: Electric window either raises or lowers with the aid of a high tension spring. If this tension is not released, the arms of the regulator will spring together when the electric motor is removed and fingers could be broken or cut off.)

D. Remove motor from regulator assembly

1. Have motor cleaned or repaired

2. Replace with a replacement unit

E. Replace electric motor on regulator assembly

F. Using test battery and jumper wire, test operation of regulator assembly

G. Replace regulator and trim panel

CIRCUITS AND WIRES
UNIT III

TEST

1. Match the following terms with the correct definitions.

______a. Unintentional ground caused by failure of the system due to an accident or wear

______b. Occurs when a conductor (wire) is broken or connections are poor and current is unable to flow

______c. Placed in a series with the circuit, it makes or breaks the current

______d. A device for lighting a given area

______e. Unit of measurement of the amount of current passing a given point each second

______f. A bulb with only one filament

______g. Electric current that flows first in one direction through the circuit, then reverses and flows in the opposite direction

______h. Electricity has two or more paths through which to travel

______i. Electricity travels through a conductor to the work load and back through a conductor to the source completing the circuit

1. Conductor
2. Amperage
3. Insulator
4. Voltage
5. Direct current
6. Resistance
7. Alternating current
8. Open circuit
9. Series circuit
10. Short circuit
11. Circuit
12. Series-Parallel circuit
13. Parallel circuit
14. Switch
15. Secondary wire
16. Terminal
17. Fuse
18. Primary wire
19. Circuit breaker
20. Bulb
21. Double filament
22. Short

_____j. Combination of series and parallel circuits

_____k. Occurs when two or more wires touch each other; the current takes the path of the least resistance and an excessively large amount of current flows under these conditions

_____l. Carries the electric current from the source to the load and back to the source

_____m. Constructed of a glass tube and a thin metal strip; when too much current passes through the fuse, the strip will melt stopping the flow of current

_____n. Unit of measure of the electrical pressure in a circuit as measured with a voltmeter

_____o. A mechanical device activated by heat; when the amperage exceeds the device's safety rating, a set of contact points open stopping the flow of current

_____p. A bulb with two filaments

_____q. Electricity has only one path through which to travel

_____r. Low tension wire used for low voltage ignition, lighting, and accessory circuits

_____s. Prevents electric current from leaking (shorting) to another conductor

23. Filament
24. Single filament
25. Wiring harness

_____t. Electric current that flows in one direction through the circuit

_____u. Any system of wires which are taped together for electric distribution throughout the automobile

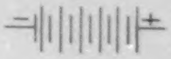
_____v. Connecting device used to attach the wires (circuits) to the different electrical components

_____w. High tension wire used for high voltage ignition circuits as in spark plugs and coil wires

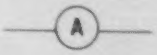
_____x. Fine, coiled tungsten wires which are vacuum sealed in a glass chamber

_____y. An ohm is the unit of measurement of the resistance in a circuit opposing a flow of one ampere moved by a pressure of one volt

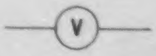
2. Identify the symbols used for electric components.



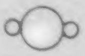
a. ____________________



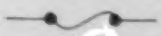
b. ____________________



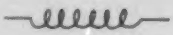
c. ____________________



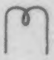
d. ____________________



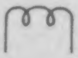
e. ____________________



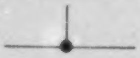
f. ____________________



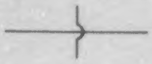
g. ____________________



h. ____________________

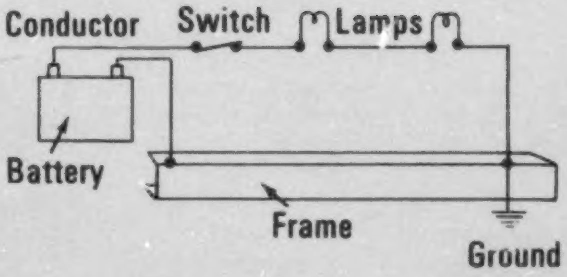


i. ____________________

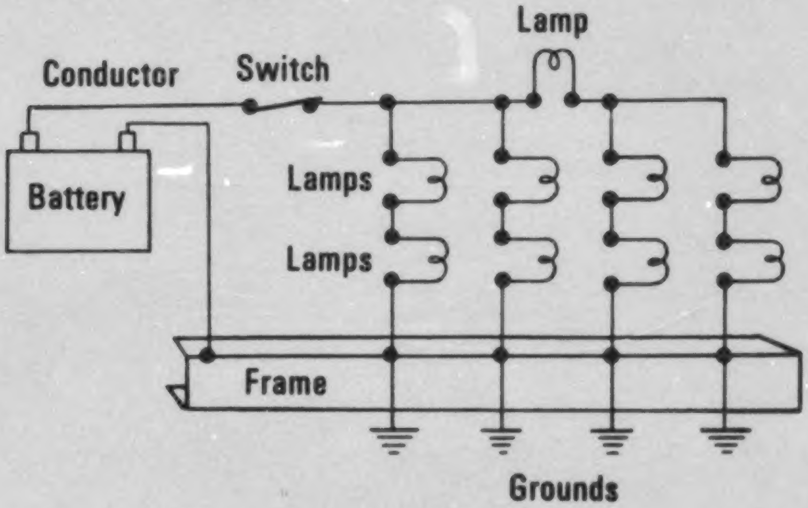


j. ____________________

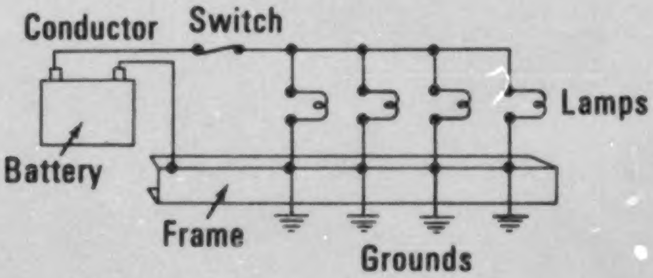
3. Identify the three types of circuits.


Conductor
Switch
Lamps
Battery
Frame
Ground

a. ______________________________


Lamp
Conductor
Switch
Lamps
Lamps
Battery
Frame
Grounds

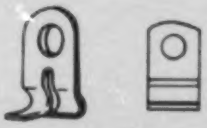
b. ______________________________


Conductor
Switch
Lamps
Battery
Frame
Grounds

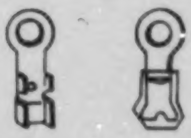
c. ______________________________

4. Match a list of terminals to illustrations.

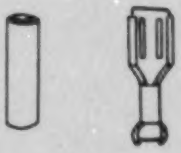
_____a.



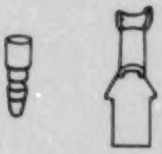
_____b.



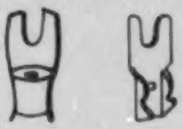
_____c.



_____d.



_____e.



1. Spade
2. Male
   a. Bullet
   b. Tab
3. Ring
4. Female
   a. Bullet
   b. Tab
5. Roll

5. Name the two common types of bulbs used in automobiles.

a.

b.

6. Name two types of splices.

a.

b.

7. Name the two sealed beams used in a dual lamp set up.

a.

b.

8. Demonstrate the ability to:

   a. Install a soldered terminal.

   b. Install a solderless terminal.

   c. Splice a wire (solder).

   d. Splice a wire (solderless).

   e. Remove and replace a bulb.

   f. Remove and replace a sealed beam.

   g. Align headlights.

   h. Remove, clean, and replace a power window motor.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

CIRCUITS AND WIRES
UNIT III

ANSWERS TO TEST

1. a. 22
   - b. 8
   - c. 14
   - d. 20
   - e. 2
   - f. 24
   - g. 7
   - h. 13
   - i. 11
   - j. 12
   - k. 10
   - l. 1
   - m. 17
   - n. 4
   - o. 19
   - p. 21
   - q. 9
   - r. 18
   - s. 3
   - t. 5
   - u. 25
   - v. 16
   - w. 15
   - x. 23
   - y. 6
2. a. 12V battery
   - b. Ammeter
   - c. Voltmeter
   - d. Circuit breaker
   - e. Fuse
   - f. Coil
   - g. Single-filament lamp
   - h Double-filament lamp
   - i. Connected conductors
   - j. Cross-over conductors
3. a. Series
   - b. Series-Parallel
   - c. Parallel
4. a. 5
   - b. 3
   - c. 4
   - d. 2
   - e. 1
5. a. Single filament
   - b. Double filament

6. a. Solder

   b. Solderless

7. a. Single filament--High beam only

   b. Double filament--Low-high beam

8. Performance skills will be evaluated according to the criteria listed on the progress chart.

ENGINE COOLING SYSTEM
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with the engine cooling system and describe the construction and operation of the cooling system. The student should demonstrate the ability to pressure test, inspect, and correctly repair the cooling system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define nine terms associated with the cooling system.
2. State the purpose of the cooling system.
3. List three jobs that the cooling system must perform.
4. Describe two methods of cooling the internal combustion engine.
5. Identify three types of radiator hoses.
6. Describe the pressure cap action at varying temperatures.
7. Describe the operation of the variable speed fan drive.
8. List three reasons why a permanent antifreeze solution should be used in the cooling system at all times.
9. Demonstrate the ability to:
    a. Remove and replace a water pump.
    b. Remove and replace a radiator.
    c. Pressure test the cooling system.
    d. Remove, inspect, and replace V-belts.
    e. Test antifreeze solution.

ENGINE COOLING SYSTEM
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in the job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Cooling System Components

    2. TM 2--Types of Radiator Hoses

    3. TM 3--Pressure Cap Operation

D. Job sheets

1. Job Sheet #1--Remove and Replace a Water Pump

2. Job Sheet #2--Remove and Replace a Radiator

3. Job Sheet #3--Pressure Test the Cooling System

4. Job Sheet #4--Remove, Inspect, and Replace V-Belts

5. Job Sheet #5--Test Antifreeze Solution

E. Test

F. Answers to test

II. References:

A. Tobolt, William K. and Jud Purvis. *Motor Services Automotive Encyclopedia*. Homewood, Illinois: Goodheart-Willcox Co., 1965.

B. Stockel, Martin W. *Auto Service and Repair*. Homewood, Illinois: Goodheart-Willcox Co., 1969.

C. Crouse, William H. *Automotive Mechanics*. Fifth Edition. New York: McGraw-Hill Book Co., 1965.

D. Stockel, Martin W. *Auto Mechanics Fundamentals*. Homewood, Illinois: Goodheart-Willcox Co., 1969.

E. Glenn, Harold I. *Auto Mechanics*. Peoria, Illinois: Charles A. Bennett Co., 1962.

ENGINE COOLING SYSTEM
UNIT IV

INFORMATION SHEET

I. Terms and definitions (Transparency 1)

   A. Water pump--Centrifugal pump mounted at the front of the cylinder block to circulate the coolant throughout the cooling system

   B. Water jackets--Passages through the block and cylinder head that allow the coolant to circulate around the cylinders, valves, and combustion chambers

   C. Radiator--Device for holding a considerable volume of coolant in close contact with a large amount of air so that heat may be transferred from the coolant to the air

   D. Fan--Device generally mounted on the water pump hub assembly to pull a large volume of air through the openings in the radiator core

   E. Shroud--Funnel-like structure attached to the radiator and extending around and behind the fan to make the fan more effective in pulling air through the radiator

   F. Thermostat--Heat controlled valve used in the cooling system to regulate the flow of coolant between the cylinder block and radiator

   G. Pressure cap--Cap which increases the pressure within the cooling system several pounds per square inch allowing the coolant to circulate at higher temperatures without evaporation or surge loss

   H. Radiator hose--Hose used to connect the radiator to the engine

   I. V-Belt--Belt turned by a pulley on the front of the crank shaft to drive the water pump, fan, and other engine accessories

II. Purpose of cooling system--To keep the engine at its most efficient operating temperature during all engine speeds and driving conditions

III. Jobs the cooling system performs

   A. Removes surplus or unwanted heat

   B. Maintains an efficient temperature under all operating conditions

   C. Brings an engine, when started, up to operating temperature as soon as possible

INFORMATION SHEET

IV. Methods of engine cooling

   A. Liquid–Uses circulating coolant for engine heat removal

   B. Air–Uses a fan, cooling fins, and engine shrouding for heat removal

V. Types of radiator hoses (Transparency 2)

   A. Common–Straight hose made of rubber with one or two layers of fabric for strength; will not stand much bending without collapsing

   B. Molded or shaped–Hose made of rubber with one or two layers of fabric for strength; all necessary bends are molded in

   C. Accordion type–Hose that will stand severe bending without collapsing; reduces transfer of vibrations from engine to radiator

VI. Pressure cap action (Transparency 3)

   A. Pressure cap fits over the radiator filler tube and seals tightly around the edges holding pressure in cooling system to improve cooling and prevent evaporation or surge loss at normal temperature

   B. Blow-off valve opens to release excess pressure in the cooling system when very hot

   C. Vacuum valve opens to allow air to enter cooling system during the cool-off period to prevent collapse of the radiator and hoses

VII. Variable speed fan drive operation

   A. When engine temperatures are high, fan speed is increased to aid cooling

   B. When engine temperatures are low, fan speed is decreased to conserve engine power

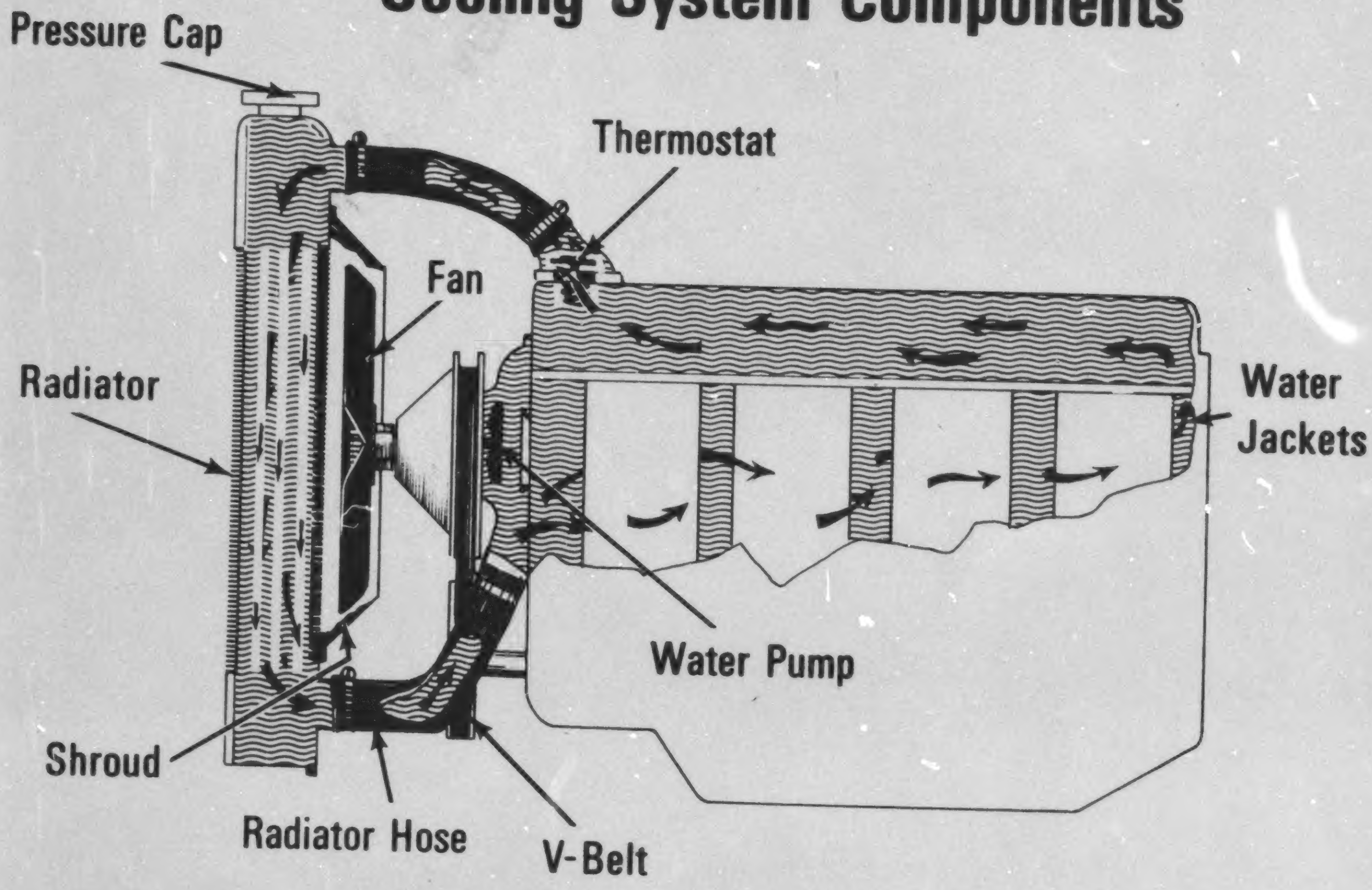
VIII. Reasons for using permanent type antifreeze

   A. Prevents coolant from freezing

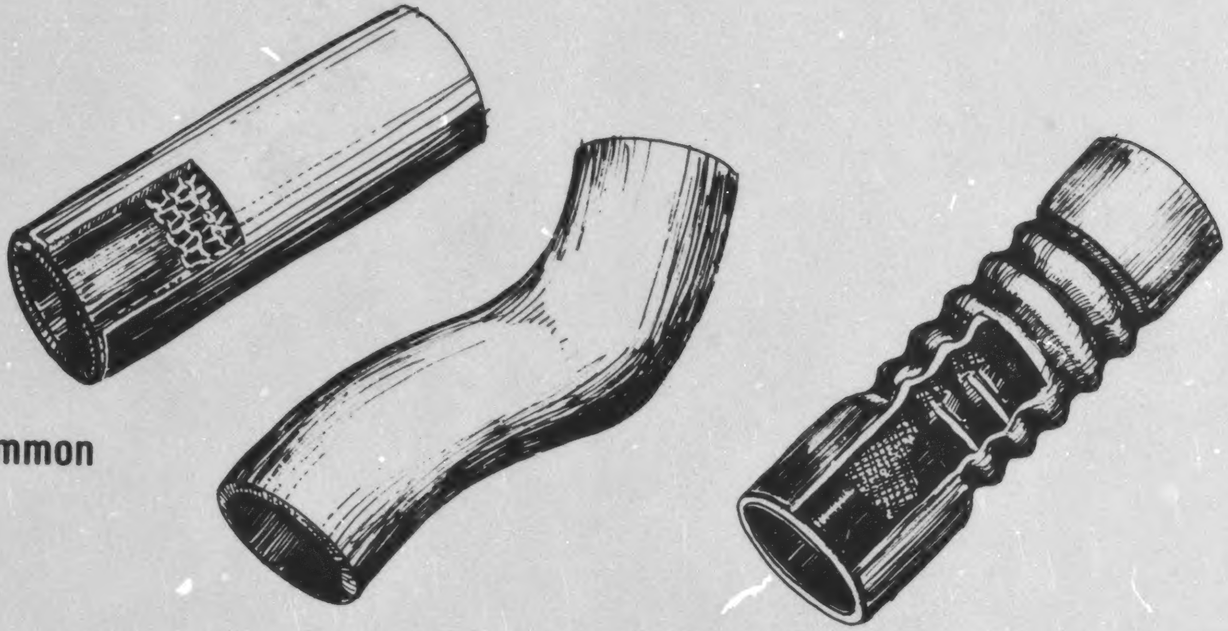
   B. Has higher boiling point than water

   C. Reduces the corrosive action of water

Cooling System Components


Pressure Cap
Thermostat
Fan
Radiator
Water Jackets
Water Pump
Shroud
Radiator Hose
V-Belt

Types of Radiator Hoses



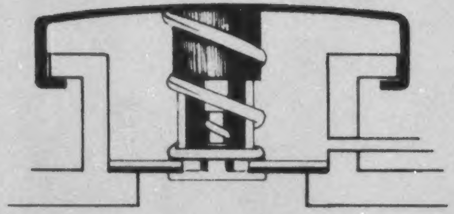
Common

Molded or Shaped

Accordion

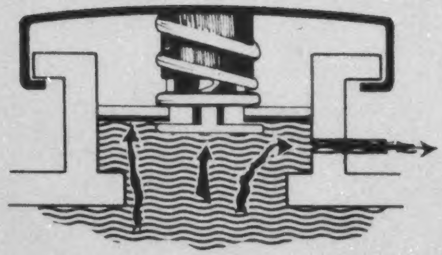
Pressure Cap Operation

Normal Operation



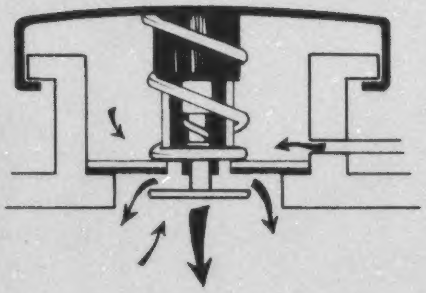
Valves Closed

Excessive Pressure



Pressure Valve Open

Cooling-Off Period



Vacuum Valve Open

TM 3

ENGINE COOLING SYSTEM
UNIT IV

JOB SHEET #1-REMOVE AND REPLACE A WATER PUMP

I. Tools and materials needed

A. Drain pan

B. Combination end wrenches, 1/2"-3/4"

C. Sockets, 3/8"-3/4" by 3/8" drive

D. Ratchet, 3/8" drive

E. Extension, 3/8" drive, approximately 6" long

F. Hose clamp pliers

G. Gasket scraper

H. Gasket sealer

I. Torque wrench

J. Screwdriver

K. Radiator fill can

II. Procedure

A. Drain cooling system

B. Remove drive belts

C. Remove fan

(NOTE: Usually the fan must be removed before the fan shroud.)

D. Remove fan shroud

E. Determine type of water pump

(NOTE: Some water pumps are small, attached to the front engine housing, and usually held in place by four bolts. Other pumps are attached to the block and require lower hose removal.)

F. Remove lower hose if required

G. Remove water pump retainer bolts

JOB SHEET #1

H. Remove water pump

I. Clean all gasket material and all rust from gasket surface

J. Apply gasket sealer to gasket surface

K. Place gasket on water pump

(NOTE: Sometimes it will be necessary to place the gasket on the block for convenience of installation.)

L. Replace water pump and start retainer bolts

(NOTE: Replace bolts in same holes they came out of.)

M. Tighten water pump retainer bolts uniformly and torque to specifications

N. Replace lower hose

O. Replace fan shroud if used

P. Replace fan assembly

(NOTE: Make sure fan is placed correctly to draw air through the radiator.)

Q. Replace drive belts

R. Adjust belts to manufacturer's specifications

S. Follow manufacturer's recommended procedure for water pump break-in

T. Close radiator drain

U. Fill radiator with coolant

V. Start engine, allow warm-up time, and check for leaks

ENGINE COOLING SYSTEM
UNIT IV

JOB SHEET #2--REMOVE AND REPLACE A RADIATOR

I. Tools and materials needed

   A. Hose clamp pliers

   B. Screwdriver

   C. End wrenches, 3/8"-3/4"

   D. Ratchet, 3/8" drive

   E. Extension, 3/8" drive, 4" long

   F. Sockets, 3/8"-3/4" to fit 3/8" drive

II. Procedure

   A. Drain radiator

   B. Disconnect upper radiator hose from radiator

   C. Disconnect lower radiator hose from radiator

   D. Remove fan shroud attaching screws

   E. Move fan shroud toward the engine back over the fan assembly

   F. Disconnect automatic transmission cooler lines if used

   (NOTE: It will be necessary to use a back-up wrench when removing lines to avoid damage to the fitting and radiator.)

   G. Remove radiator attaching bolts

   H. Remove radiator

   (NOTE: With the radiator removed, the air passages should be cleaned using compressed air. The radiator mounting shell should be checked for breaks or cracks.)

   I. Replace the radiator

   J. Position radiator and start attaching bolts

   (NOTE: Make sure fan shroud is in place before radiator is replaced.)

JOB SHEET #2

K. Tighten radiator attaching bolts

L. Replace transmission cooler lines and tighten securely

(NOTE: It will be necessary to use a back-up wrench when tightening lines to prevent damage to fittings and the radiator.)

M. Move fan shroud into place, install attaching screws, and tighten securely

N. Inspect hoses to determine if replacement is necessary

O. Replace lower hose and tighten clamps securely

P. Replace upper hose and tighten clamps securely

Q. Close radiator drain cock

R. Refill radiator with recommended coolant

S. Start engine, allow warm-up, and recheck coolant level

ENGINE COOLING SYSTEM
UNIT IV

JOB SHEET #3--PRESSURE TEST THE COOLING SYSTEM

I. Tool needed--Radiator pressure tester

II. Procedure

A. Remove radiator cap

(CAUTION: Never remove the radiator cap quickly when the engine is hot. If cap must be removed when hot, loosen cap using a towel or cap removing wrench to first stop and leave in this position until all pressure is released. Cap may then be removed safely.)

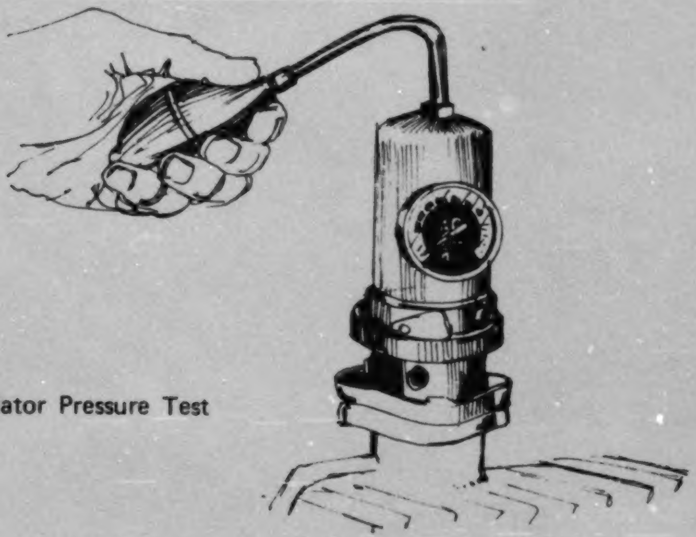
B. Wipe the radiator filler cap seat clean

C. Attach the radiator pressure tester

D. Apply pressure

(NOTE: Pressure applied should not exceed recommended cooling system pressure by more than 1 psi.) (Figure 1)

FIGURE 1



Radiator Pressure Test

1. Pressure holds steady--The cooling system is not leaking

JOB SHEET #3

2. Pressure drops--Check for external leaks in hose connections, expansion plugs, water pump, and radiator

3. Pressure drops but external leaks are not visible-- Remove tester; start and run engine until operating temperature is reached

E. Reattach tester and apply cooling system pressure

F. Increase engine speed to half throttle

1. If pressure needle fluctuates, this indicates a combustion leak

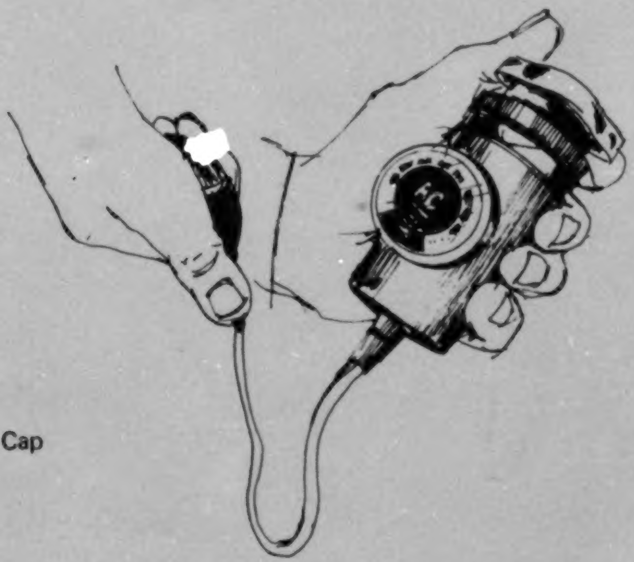
2. If pressure meter needle does not fluctuate, sharply accelerate engine several times and check for a discharge of water from the tailpipe

(NOTE: If an abnormal amount of water is discharged at the tailpipe, this could indicate a cracked block or head or a defective head gasket.)

G. Test the pressure cap

(NOTE: Use same tester with adapter to test cap. If the cap does not hold the rated pressure, it should be replaced.) (Figure 2)

FIGURE 2



Testing the Radiator Cap

H. With test completed, check coolant level and reinstall cap

ENGINE COOLING SYSTEM
UNIT IV

JOB SHEET #4--REMOVE, INSPECT, AND REPLACE V-BELTS

I. Tools and materials needed

  A. Combination end wrenches, 1/2"-5/8"

  B. Pry bar

  C. V-Belt tension gauge

II. Procedure

  A. Disconnect battery

  B. Locate slotted adjustment holes on brace or component to be adjusted

  C. Loosen necessary bolts to allow component movement

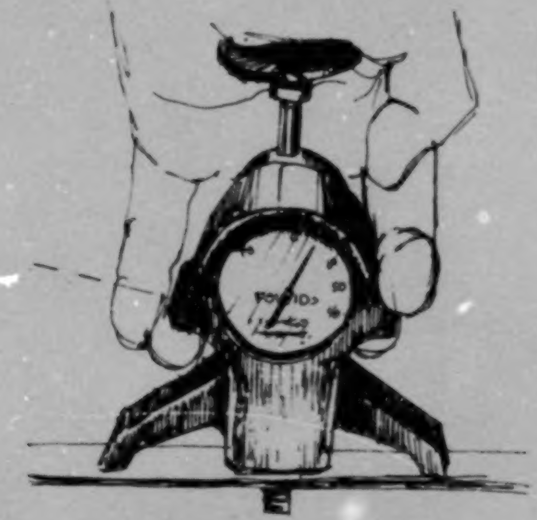
  D. Move component toward block to allow V-belt removal

  E. Inspect V-belt for cracks, glazing, fraying, or any condition that will make the belt unreliable or inefficient to use

  F. Replace V-belt

  G. Adjust belt tension to manufacturer's specifications (Figure 1)

FIGURE 1



Checking Fan Belt Tension

(NOTE: New belt tension will vary from used belt tension.)

JOB SHEET #4

H. Check the tension by measuring the amount of belt deflection

I. Tighten all brackets and braces securely while holding tension on belt

J. Recheck tension

K. Reconnect battery cables

ENGINE COOLING SYSTEM
UNIT IV

JOB SHEET #5--TEST ANTIFREEZE SOLUTION

I. Tool needed--Antifreeze hydrometer tester

II. Procedure

A. Start engine and allow time for coolant to warm up to operating temperature

B. Remove radiator cap

(NOTE: Never remove the radiator cap quickly when the engine is hot. Loosen cap using radiator cap tool or shop towel slowly to first stop and leave in this position until all pressure is released. Cap may then be removed safely.)

C. Draw coolant into tester and empty several times to equalize the temperature of all parts

D. Draw coolant into tester

(NOTE: Read the first number or letter on the float above the liquid surface. Note temperature of coolant. Using these two readings and the chart on the tester, the antifreeze content of the water can be measured.)

E. Make sure the antifreeze content is such that the cooling system will be protected to 10° F. lower than coldest temperature expected

F. Add antifreeze if necessary

(NOTE: Allow room for expansion.)

ENGINE COOLING SYSTEM
UNIT IV

TEST

1. Define the following terms.

   a. Water pump--

   b. Water jackets--

   c. Radiator--

   d. Fan--

   e. Shroud--

   f. Thermostat--

   g. Pressure cap--

   h. Radiator hose--

   i. V-Belt--

2. State the purpose of the cooling system.

3. List three jobs that the cooling system must perform.

   a.

   b.

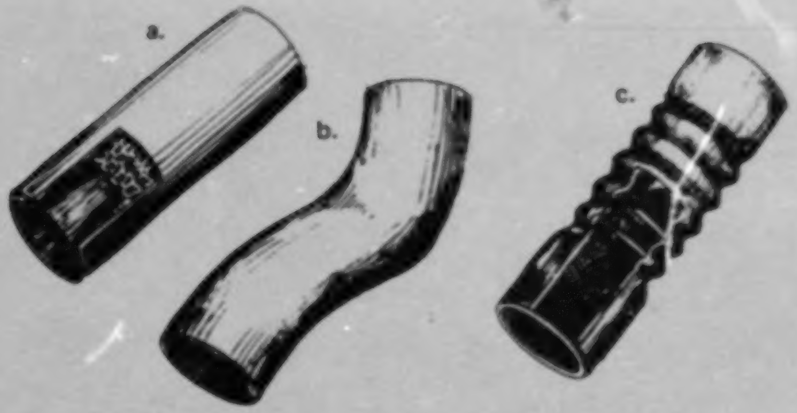
   c.

4. Describe briefly the following methods of cooling the internal combustion engine.

   a. Liquid--

   b. Air--

5. Identify the following types of radiator hoses.



a. ______________________

b. ______________________

c. ______________________

6. Describe the pressure cap action during each of the following temperatures.

a. Cooling system at normal temperature--

b. Cooling system very hot with excess pressure built up--

c. Cooling system during cooling off period--

7. Describe the operation of the variable speed fan drive.

8. List three reasons why a permanent antifreeze solution should be used in the cooling system at all times.

   a.

   b.

   c.

9. The students should demonstrate the ability to perform the following jobs to the satisfaction of the instructor.

   a. Remove and replace a water pump.

   b. Remove and replace a radiator.

   c. Pressure test the cooling system.

   d. Remove, inspect, and replace V-belts.

   e. Test antifreeze solution.

   (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

ENGINE COOLING SYSTEM
UNIT IV

ANSWERS TO TEST

1. a. Water pump--Centrifugal pump mounted at the front of the cylinder block to circulate the coolant throughout the cooling system

   b. Water jackets--Passages through the block and cylinder head that allow coolant to circulate around the cylinders, valves, and combustion chambers

   c. Radiator--Device for holding a considerable volume of coolant in close contact with a large amount of air so that heat may be transferred from the coolant to the air

   d. Fan--Device generally mounted on the water pump hub assembly to pull a large volume of air through the openings in the radiator core

   e. Shroud--Funnel-like structure attached to the radiator and extending around and behind the fan to make the fan more effective in pulling air through the radiator

   f. Thermostat--Heat controlled valve used in the cooling system to regulate the flow of coolant between the cylinder block and radiator

   g. Pressure cap--Cap which increases the pressure within the cooling system several pounds per square inch allowing the coolant to circulate at higher temperatures without evaporation or surge loss

   h. Radiator hose--Hose used to connect the radiator to the engine

   i. V-Belt--Belt turned by a pulley on the front of the crank shaft to drive the water pump, fan, and other engine accessories

2. Purpose of cooling system--To keep the engine at its most efficient operating temperature during all engine speeds and driving conditions

3. a. Removes surplus or unwanted heat

   b. Maintains an efficient temperature under all operating conditions

   c. Brings an engine, when started, up to operating temperature as soon as possible

4. Description should include:

   a. Liquid--Uses circulating coolant for engine heat removal

   b. Air--Uses a fan, cooling fins, and engine shrouding for heat removal

5. a. Common

   b. Molded or shaped

   c. Accordion type

6. Description should include:

   a. Pressure cap fits over the radiator filler tube and seals tightly around the edges holding pressure in cooling system to improve cooling and prevent evaporation and surge loss

   b. Blow-off valve opens to release excess pressure in the cooling system

   c. Vacuum valve opens to allow air to enter cooling system during the cool-off period to prevent collapse of the radiator and hoses

7. When engine temperatures are high, the fan speed is increased to aid cooling; when engine temperatures are low, fan speed is decreased to conserve engine power

8. a. Prevents coolant from freezing

   b. Has higher boiling point than water

   c. Reduces the corrosive action of water

9. Performance skills will be evaluated according to the criteria listed on the progress chart.

AIR CONDITIONING
UNIT V

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to service an automotive air conditioning system. He should be able to use air conditioning equipment, purge the system, repair and replace a condenser, evacuate, leak test, repair minor leaks, and charge the system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the air conditioning system to the correct definition.
2. Identify from a drawing the high and low sides of a compressor.
3. Identify the components of the refrigeration system.
4. Explain the purpose of a receiver-dehydrator (drier).
5. Identify the back seat, midposition, and front seat of a service valve.
6. Identify the components of a manifold system.
7. Demonstrate the ability to:
    a. Connect the manifold gauge set into the system.
    b. Purge the system.
    c. Repair or replace a condenser.
    d. Evacuate the system using a vacuum pump or charging station.
    e. Leak test the system using a leak detector.
    f. Repair leaks in the air conditioning system.
    g. Charge the air conditioning system using pound cans.

AIR CONDITIONING
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1--What an Air Conditioner Does

      2. TM 2--Change of State in an Air Conditioning System

      3. TM 3--Basic Air Conditioning System Refrigerant Flow Cycle

4. TM 4--High and Low Sides of a Refrigeration System
5. TM 5--Compressors
6. TM 6--Compressor Operation
7. TM 7--Condenser
8. TM 8--Receiver-Drier
9. TM 9--Sight Glass Indications
10. TM 10--Thermostatic Expansion Valve
11. TM 11--Evaporator
12. TM 12--R-12 Refrigerant
13. TM 13--Refrigerant Can Valve Installation
14. TM 14--Test Gauge Manifold Set
15. TM 15--Service Valves
16. TM 16--Gauge Test Set Connection to System (Purging)
17. TM 17--Pressure-Temperature Relationship
18. TM 18--Adding Refrigerant to System
19. TM 19--Halide Leak Detector
20. TM 20--Discharging the System
21. TM 21--Evacuating the System

D. Job sheets

1. Job Sheet #1--Connect Manifold Gauge Set into System
2. Job Sheet #2--Purge the System
3. Job Sheet #3--Repair or Replace Condenser
4. Job Sheet #4--Evacuate the System Using a Vacuum Pump or Charging Station
5. Job Sheet #5--Leak Test the System Using a Halide Leak Detector
6. Job Sheet #6--Repair Leaks in Air Conditioning System
7. Job Sheet #7--Charge the Air Conditioning System Using Pound Cans

E. Test

F. Answers to test

II. References:

A. *Ford Training Handbook Course 19000.* "How Air Conditioning Works." vol. 65 S7L2. March, 1965.

B. Seymour, A. T., J. R. Wright, and William Dean Conaster. *Automotive Air Conditioning Theory and Basic Service.* San Diego, California: National Automotive Service, Inc., 1970.

AIR CONDITIONING
UNIT V

INFORMATION SHEET

I. Terms and definitions (Transparencies 1-21)

A. Air conditioner--A device used to control temperature, humidity, and air movement

B. Air inlet valve--An adjustable door in the plenum blower assembly that permits selection of outside and inside air for heating and cooling systems

C. Ambient air temperature--Temperature of air surrounding an air conditioned unit, such as a vehicle or building

D. Ambient switch--An outside air sensing switch used to control compressor clutch operation and prevent compressor operation at low temperatures when air conditioning is not required

E. Back seat--Refers to turning the service valve stem all the way counterclockwise and "back seating" the valve

(NOTE: In this position the valve outlet to the system is open and the service port in the valve is closed. This is its normal operating position.)

F. Blower fan--A motor driven fan used to force air through the evaporator and to circulate the cooled air through the passenger compartment of the automobile

G. Boiling point--Temperature at which a liquid changes to a vapor

H. Can valve--Mechanical device used to pierce, dispense, and seal small cans of refrigerant

I. Charge--A specific amount of refrigerant or oil by volume or weight

J. Charging--The act of placing a charge of refrigerant or oil into the air conditioning system

K. Circuit breaker--A bimetal device used instead of a fuse to protect a circuit

L. Compound gauge--A gauge that will register both pressure and vacuum; used on the low side of the system

INFORMATION SHEET

M. Compressor--Component of the refrigeration system that pumps refrigerant vapor and increases the pressure of refrigerant

N. Compressor shaft seal--An assembly mounted on the compressor crankshaft permitting the shaft to be turned without loss of refrigerant or oil

O. Condensation--The act of changing a vapor to a liquid

P. Condenser--Component of a refrigeration system in which refrigerant vapor is changed to a liquid by the removal of heat

Q. Contaminants--Anything other than refrigerant and refrigeration oil in the system

R. Desiccant--A drying agent used in refrigeration systems to remove excess moisture

S. Discharge--To bleed some or all of the refrigerant from a system by opening a valve or connection and permitting the refrigerant to escape slowly

T. Discharge line--Connects the compressor outlet to the condenser inlet

U. Discharge side--That portion of the refrigeration system under high pressure, extending from the compressor outlet to the thermostatic expansion valve inlet

V. Drier--A device containing desiccant placed in the liquid line to absorb moisture in the system

(NOTE: This is ordinarily combined with the receiver.)

W. Drive pulley--A V-pulley attached to the crankshaft of an automobile used to drive the compressor clutch pulley by use of a belt

(NOTE: Some systems are equipped with an idler pulley to adjust belt tension.)

X. Evacuate--To create a vacuum within a system to remove all trace of air and moisture

Y. Evaporator--Component of an air conditioning system in which refrigerant liquid is changed into a vapor by removing heat from the air which is then discharged into the passenger compartment

Z. Fahrenheit--A thermometer scale using 32° as the freezing point of water and 212° as the boiling point of water

(NOTE: Fahrenheit is the scale used by air conditioning technicians in the U.S.)

INFORMATION SHEET

AA. Filter--A device used with the drier or as a separate unit to remove foreign solid material from the refrigerant

BB. Flooding--A condition caused by too much liquid refrigerant being metered into the evaporator

(NOTE: This condition is detected by frosting of the suction line.)

CC. Flush--To remove solid particles such as metal flakes or dirt from refrigerant passages

DD. Foaming--The formation of a froth of the oil and refrigerant due to rapid boiling out of the refrigerant dissolved in the oil when the pressure is suddenly reduced

(NOTE: Foam in the sight glass is an indication of a very low refrigerant level.)

EE. Freeze up--Failure of a unit to operate properly due to the formation of ice at the expansion valve orifice or on the evaporator coils or fins

FF. Front seat--Closing of the compressor service valves by turning them all the way in, clockwise

(NOTE: This position is used only to "isolate" the compressor. The compressor is never operated with valves in this position.)

GG. Fuse--An electrical device used to protect a circuit against accidental overload or unit malfunction

HH. Head pressure--Pressure of the refrigerant from the discharge reed valve through lines and condenser to the expansion valve orifice

II. High head pressure--A term used when the head or high side pressure of the system is excessive

JJ. High side service valve--A device located on the discharge side of the compressor to allow the serviceman to check high side pressures and perform other necessary operations

KK. High suction pressure--Low side pressure higher than normal due to a malfunction of the system

LL. Insulate--To isolate or seal off with a nonconductor

MM. Leak detector--Any device used to detect leaks in an air conditioning system

(NOTE: These include dyes, solutions, an electronic unit, or a halide torch.)

INFORMATION SHEET

NN. Liquid line--Line connecting the drier outlet with the expansion valve inlet

(NOTE: The line from the condenser outlet to the drier inlet is sometimes referred to as a liquid line also.)

OO. Low head pressure--High side pressure lower than normal due to a malfunction of the system

PP. Low side service valve--A device located on the suction side of the compressor to allow the serviceman to check low side pressures or perform other necessary service operations

QQ. Low suction pressure--Pressure lower than normal in the suction side of the system due to a malfunction of the unit

RR. Magnetic clutch--A coupling device used to turn the compressor on and off electrically

SS. Overcharge--Indicating too much refrigerant or refrigeration oil in the system

TT. Pressure--Force per unit of area; the pressure of refrigerant is measured in pounds per square inch (psi)

UU. Pressure drop--The difference in pressure between any two points that may be caused by a restriction or friction

VV. Purge--To remove moisture and air from a system or a component by flushing with a dry gas refrigerant

WW. Ram air--Air that is forced through the condenser coils by the movement of the vehicle or action of the fan

XX. Receiver-Drier--A combination container for the storage of liquid refrigerant and a desiccant

YY. Reciprocating compressor--A positive displacement compressor with pistons that travel back and forth in a cylinder

ZZ. Reed valves--Thin leaves of steel located in the valve plate of automotive compressors to act as suction and discharge valves

(NOTE: The suction valve is located on the bottom of the valve plate and the discharge on top.)

AAA. Refrigerant-12--Refrigerant used in automotive air conditioners

(NOTE: The proper name is Dichlorodifluoromethane. The chemical symbol is $C\ Cl_2F_2$.)

INFORMATION SHEET

BBB. Refrigeration cycle--The complete circulation of refrigerant through an air conditioning system accompanied by changes in temperature and pressure, such as changes of state from vapor-to-liquid-to-vapor

CCC. Refrigeration oil--Highly refined oil free from all contaminates, such as sulfur, moisture, and tars

DDD. Remote bulb--A sensing device connected to the expansion valve by a capillary tube to sense temperature and transmit pressure to the expansion valve for its proper operation

EEE. Schrader valve--A spring-loaded valve similar to a tire valve located inside the service valve fitting and used on some control devices to hold refrigerant in the system

(NOTE: Special adapters must be used with the gauge hose to allow access to the system.)

FFF. Screen--A metal mesh located in the receiver, expansion valve, and compressor inlet to prevent particles of dirt from being circulated through the system

GGG. Service port--A fitting on the service valves and some control devices to allow manifold set charging hoses to be connected

HHH. Short cycling--Condition caused by poor air circulation or a thermostat out of adjustment causing the air conditioning unit to run for very short periods

III. Specifications--Information provided by the manufacturer that describes an air conditioning system function

JJJ. Suction line--Line connecting the evaporator outlet to the compressor inlet

KKK. Suction side--That portion of the refrigeration system under low pressure extending from the expansion valve outlet to the compressor inlet

LLL. Suction throttling valve (STV and POA valves)--A back pressure-regulated device that prevents evaporator core freeze up; used by General Motors and consists of a rubber-like piston or bellows

MMM. Suction pressure--Compressor inlet pressure which reflects the pressure of the system on the low side

NNN. Thermostatic switch--A temperature sensitive switch used to control the compressor clutch and cycle the compressor as a means of temperature control in an air conditioning system

(NOTE: Switches are bellows or bimetal types.)

INFORMATION SHEET

OOO. Undercharge--A system short of refrigerant which will result in improper cooling

PPP. Vacuum--Referring to less than atmospheric pressure, expressed in inches of mercury

QQQ. Vacuum pump--A mechanical device used to evacuate the refrigeration system to rid it of excess moisture and air

RRR. Vapor--A gas and specifically the gaseous state of refrigerant

II. High and low sides of a compressor

  A. High side--The discharge side of the compressor

  B. Low side--The suction side of the compressor

III. Components of the air conditioning system (Transparency 3)

  A. High side

    1. Discharge side of compressor and its high side service fitting

    2. Condenser

    3. Receiver-Drier

    4. Inlet half of expansion valve

    5. Connecting hoses to all parts described above

  B. Low side

    1. Suction side of compressor and its low side service fitting

    2. Evaporator

    3. Outlet half of expansion valve

    4. Connecting hoses to all parts described above

IV. Purpose of receiver-dehydrator (drier)--Placed in the system to provide storage of liquid refrigerant and to absorb moisture in the system

V. Valve positions (Transparency 15)

  A. Front seat--Shut-off position with valve stem rotated clockwise to front seat valve face to isolate compressor from the system

  (CAUTION: The air conditioner must never be operated with the service valves front seated. This would damage the compressor as no refrigerant would be flowing through compressor and excessive head pressures would build up causing seals to blow out.)

INFORMATION SHEET

B. Midposition--Test position with valve stem turned clockwise 1 1/2 to 2 turns to connect service gauge port into system so that gauge readings may be taken with system operating

(NOTE: Midposition is sometimes referred to as "cracking the valve.")

C. Back seat--Normal operating position with valve stem rotated counterclockwise to rear seat valve face to seal off service gauge port

VI. Components of a manifold system (Transparency 14)

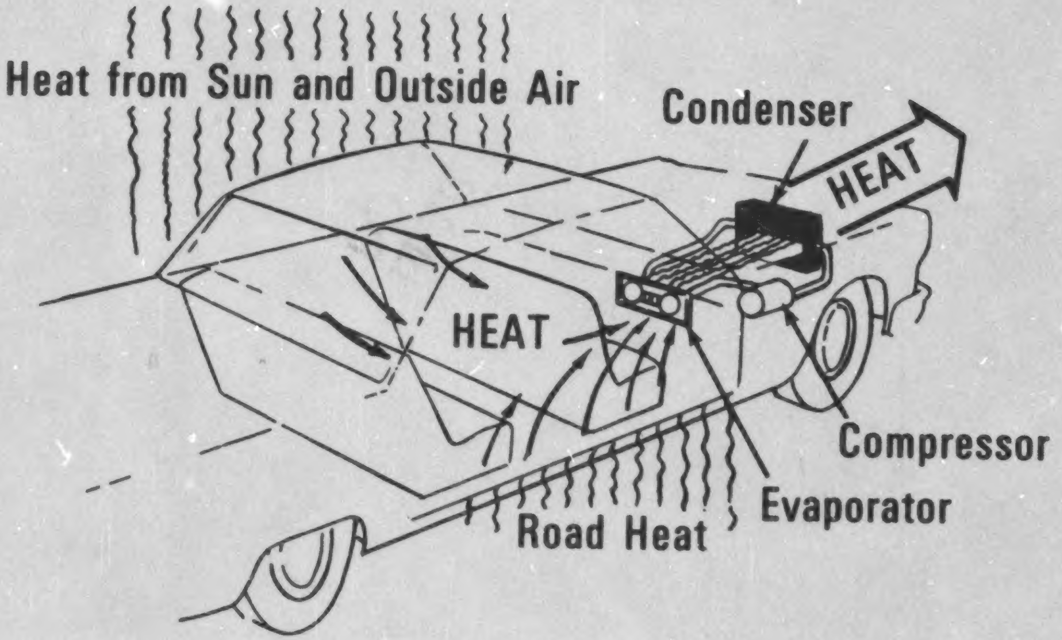
A. High pressure side

1. High side gauge
2. Manifold
3. High side hand valve
4. High side test hose

B. Low pressure side

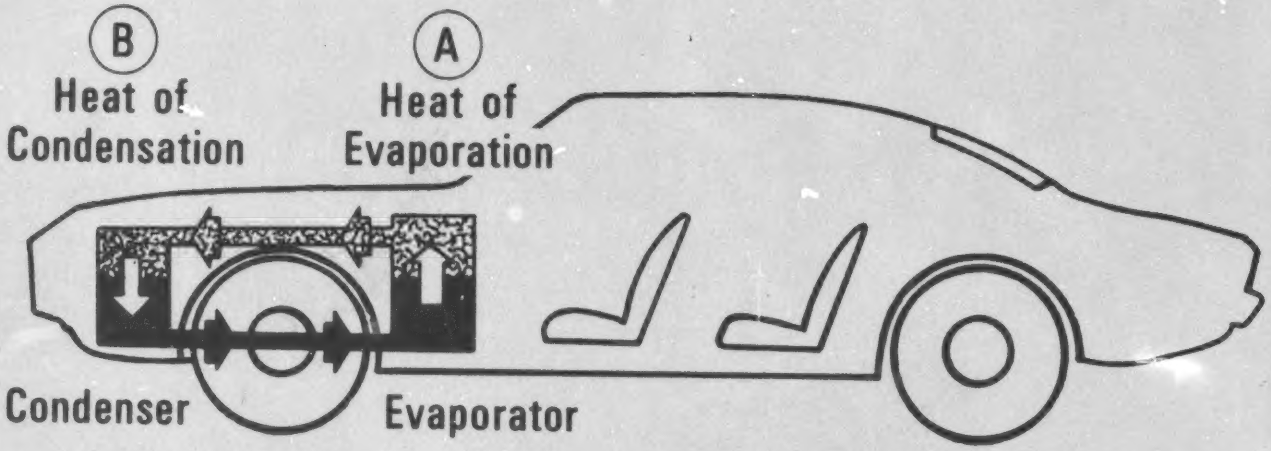
1. Low side gauge
2. Manifold
3. Low side hand valve
4. Low side test hose

What an Air Conditioner Does


Heat from Sun and Outside Air
Condenser
HEAT
HEAT
Compressor
Evaporator
Road Heat

An air conditioner is a simple mechanical device to move heat from the inside of the car to the outside.

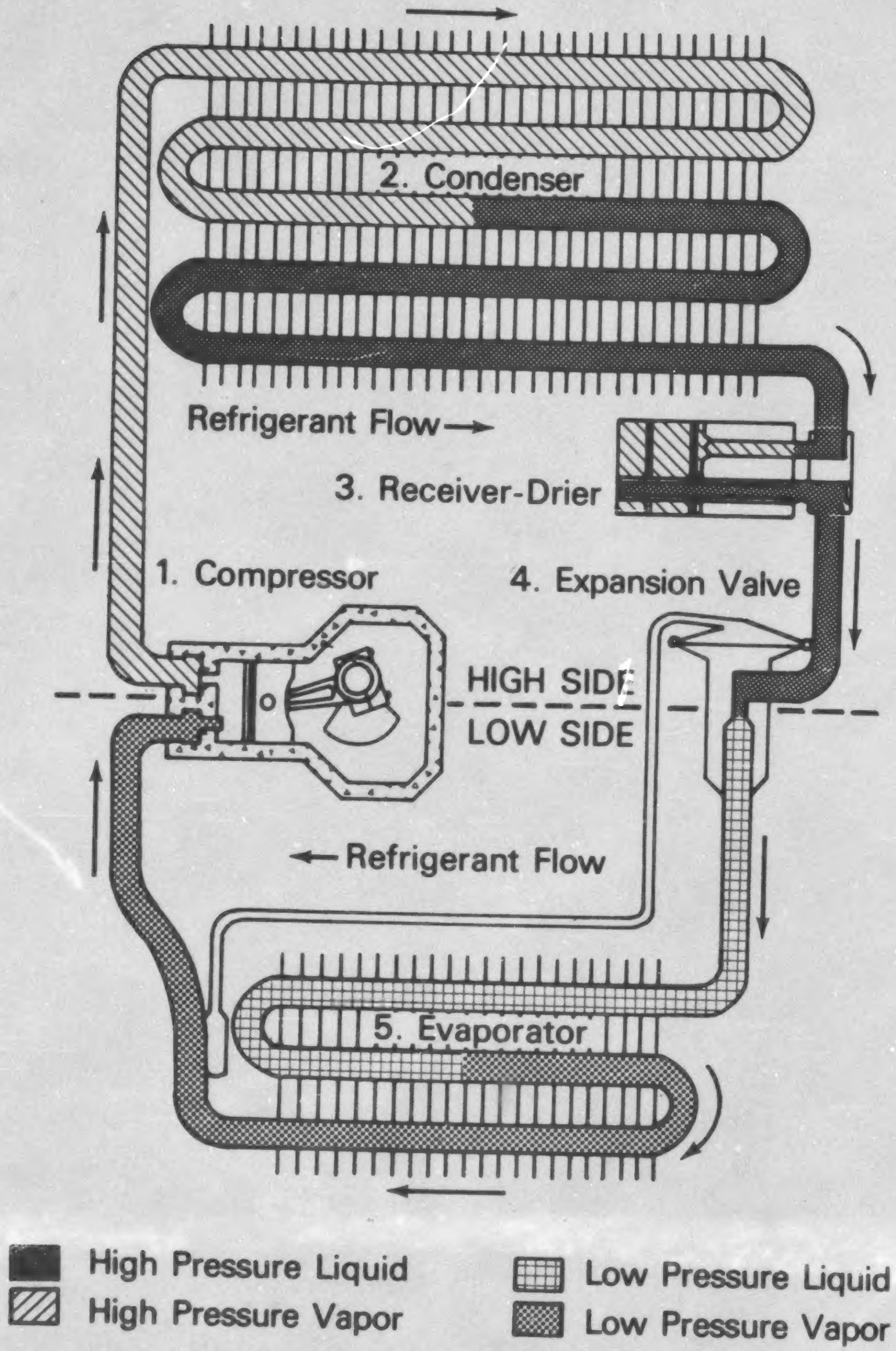
Change of State
in an Air Conditioning System


Ⓑ
Heat of
Condensation
Ⓐ
Heat of
Evaporation
Condenser
Evaporator

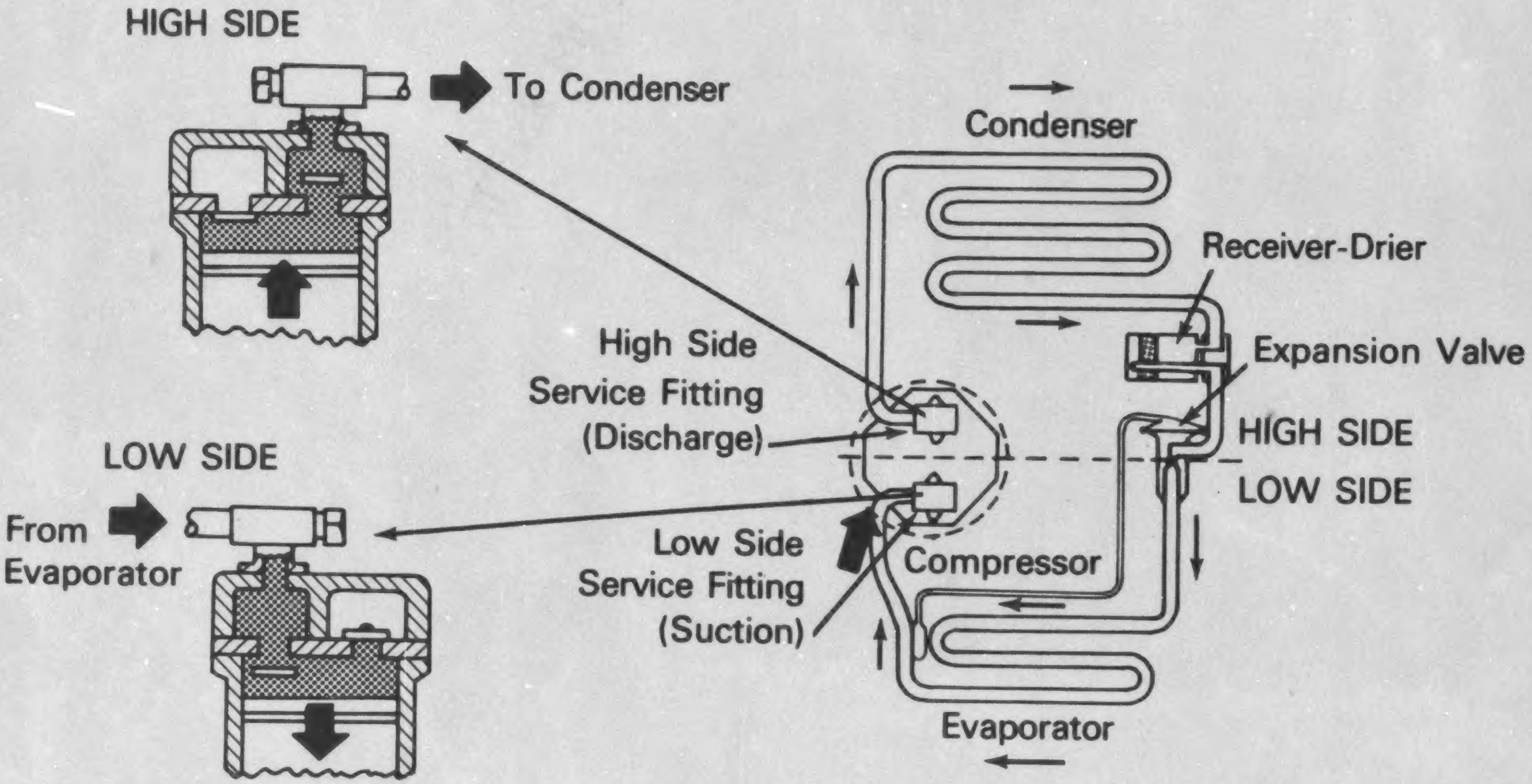
Ⓐ In the Evaporator, R-12 liquid absorbs Heat and becomes a vapor.

Ⓑ In the Condenser, R-12 vapor gives up its Heat and becomes a liquid.

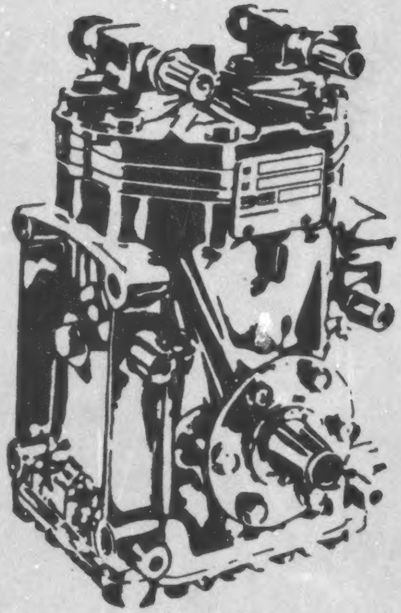
Basic Air Conditioning System
Refrigerant Flow Cycle


2. Condenser
Refrigerant Flow→
3. Receiver-Drier
1. Compressor
4. Expansion Valve
HIGH SIDE
LOW SIDE
←Refrigerant Flow
5. Evaporator
■ High Pressure Liquid
▨ High Pressure Vapor
▦ Low Pressure Liquid
▩ Low Pressure Vapor

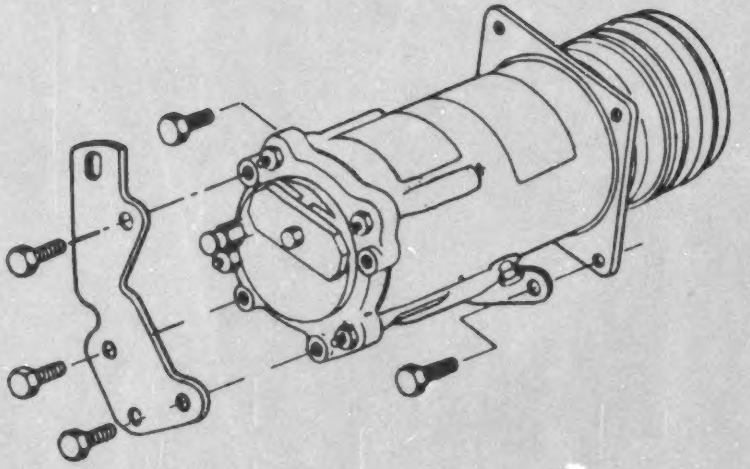
High and Low Sides of a Refrigeration System


HIGH SIDE
To Condenser
Condenser
Receiver-Drier
Expansion Valve
High Side
Service Fitting
(Discharge)
HIGH SIDE
LOW SIDE
LOW SIDE
From
Evaporator
Low Side
Service Fitting
(Suction)
Compressor
Evaporator

Compressors



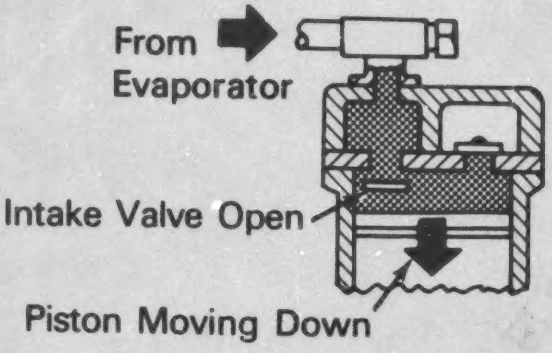
Reciprocating



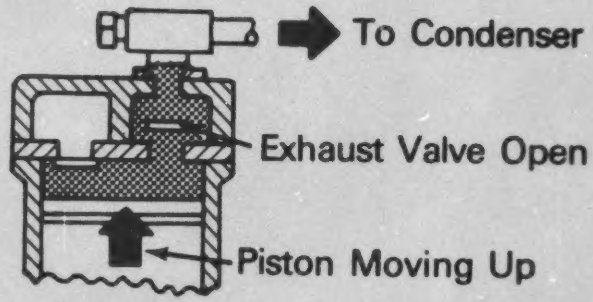
Swash Plate

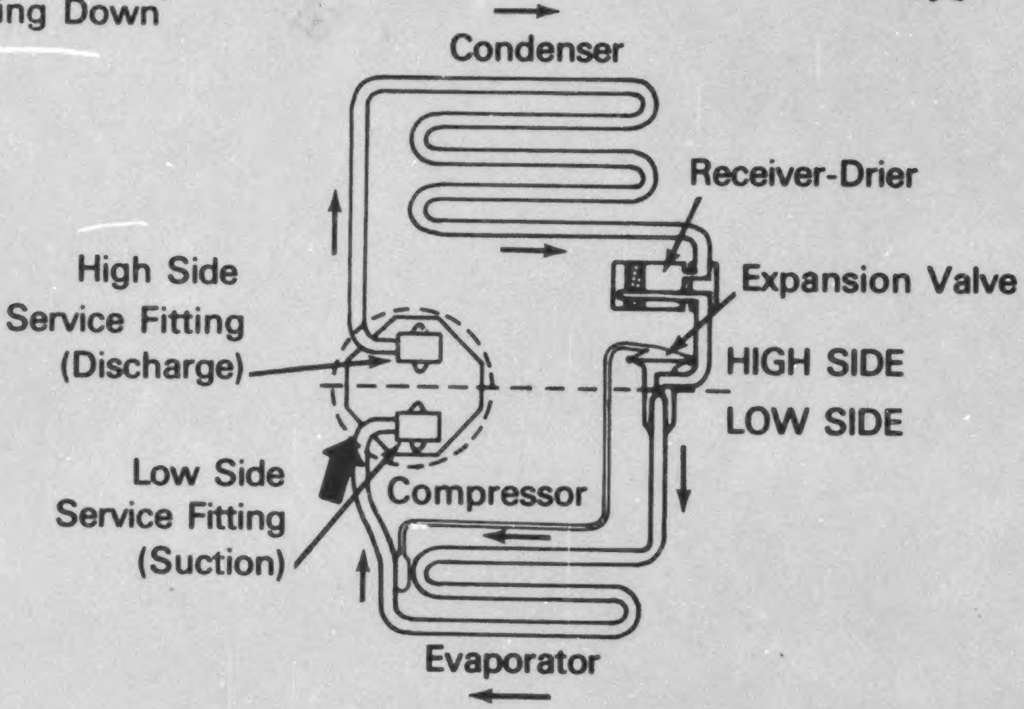
Compressor Operation

INTAKE STROKE

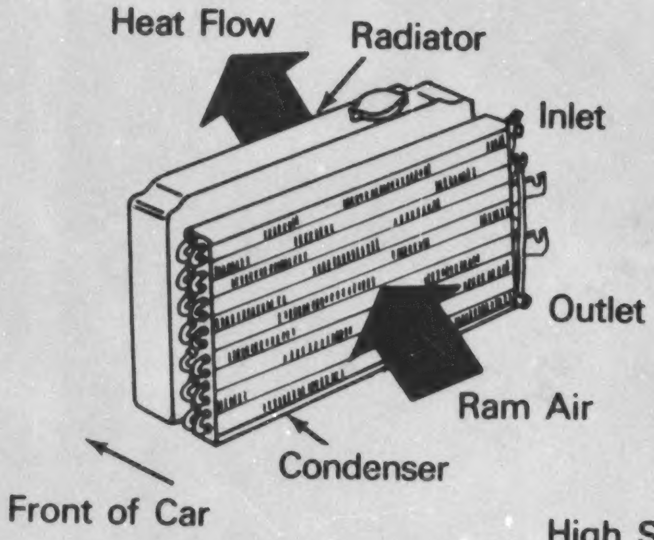

From Evaporator
Intake Valve Open
Piston Moving Down

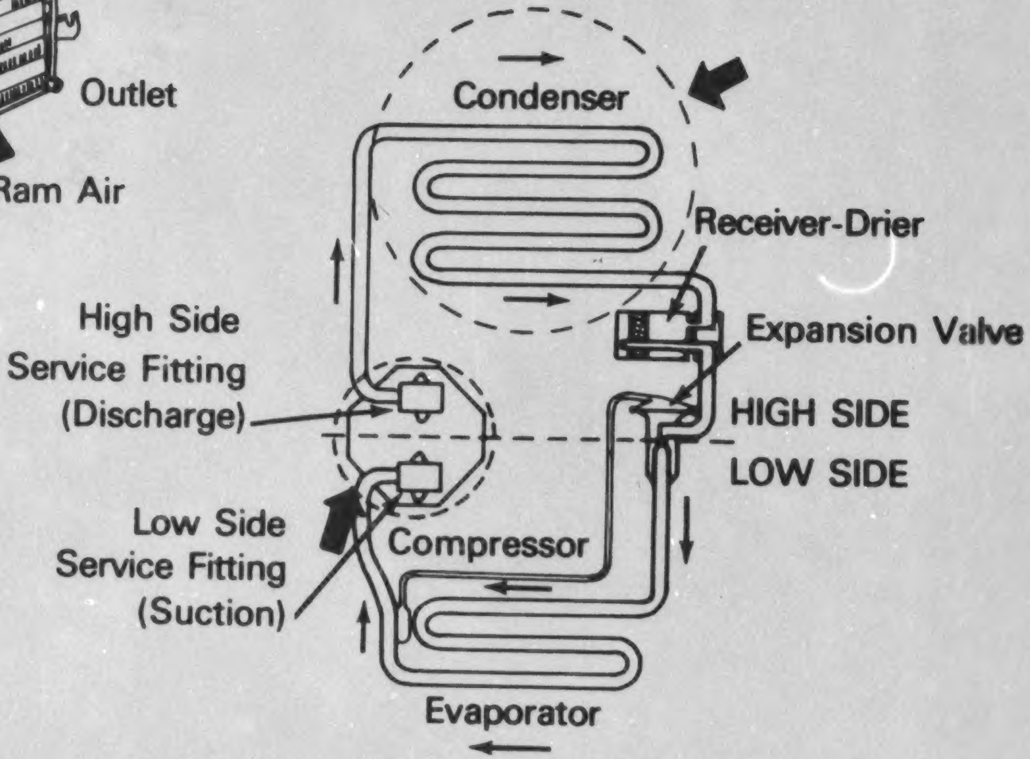
COMPRESSION STROKE


To Condenser
Exhaust Valve Open
Piston Moving Up


Condenser
Receiver-Drier
Expansion Valve
HIGH SIDE
LOW SIDE
High Side Service Fitting (Discharge)
Low Side Service Fitting (Suction)
Compressor
Evaporator

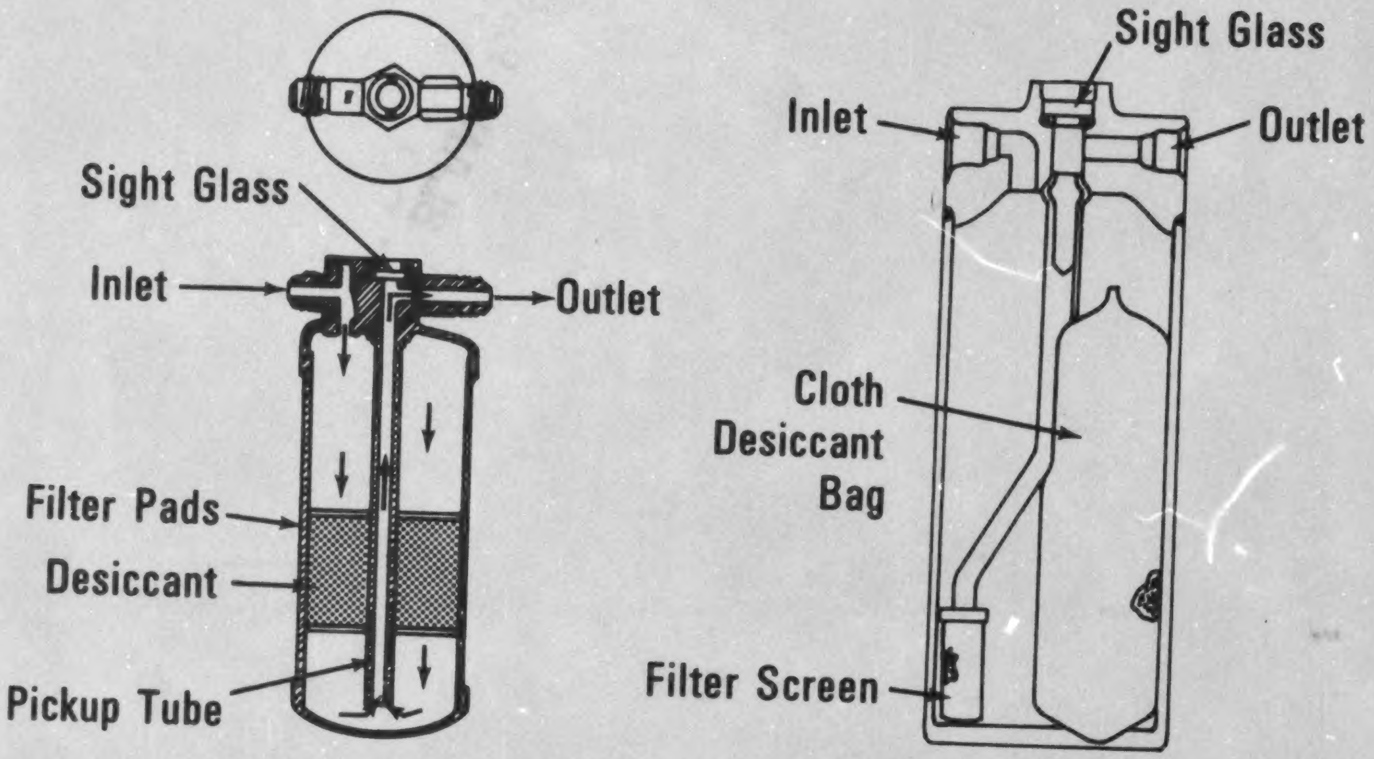
Condenser


Heat Flow
Radiator
Inlet
Outlet
Ram Air
Condenser
Front of Car

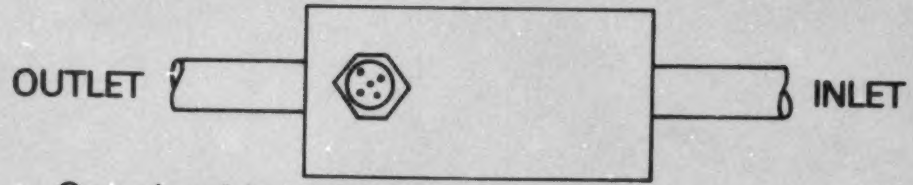

Condenser
Receiver-Drier
Expansion Valve
HIGH SIDE
LOW SIDE
High Side
Service Fitting
(Discharge)
Low Side
Service Fitting
(Suction)
Compressor
Evaporator

Receiver-Drier

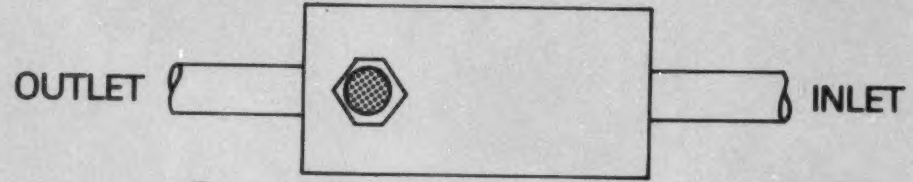
RECEIVER-DRIER ASSEMBLIES
(TYPICAL TYPES)


Sight Glass
Inlet
Outlet
Filter Pads
Desiccant
Pickup Tube
Sight Glass
Inlet
Outlet
Cloth Desiccant Bag
Filter Screen

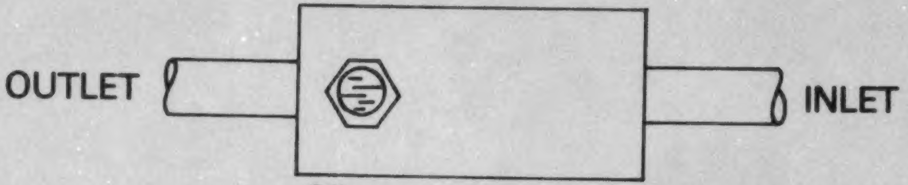
Sight Glass Indications


OUTLET
INLET

Occasional bubbles normal when starting up system
(Refrigerant slightly low or receiver-drier
saturated and releasing moisture)

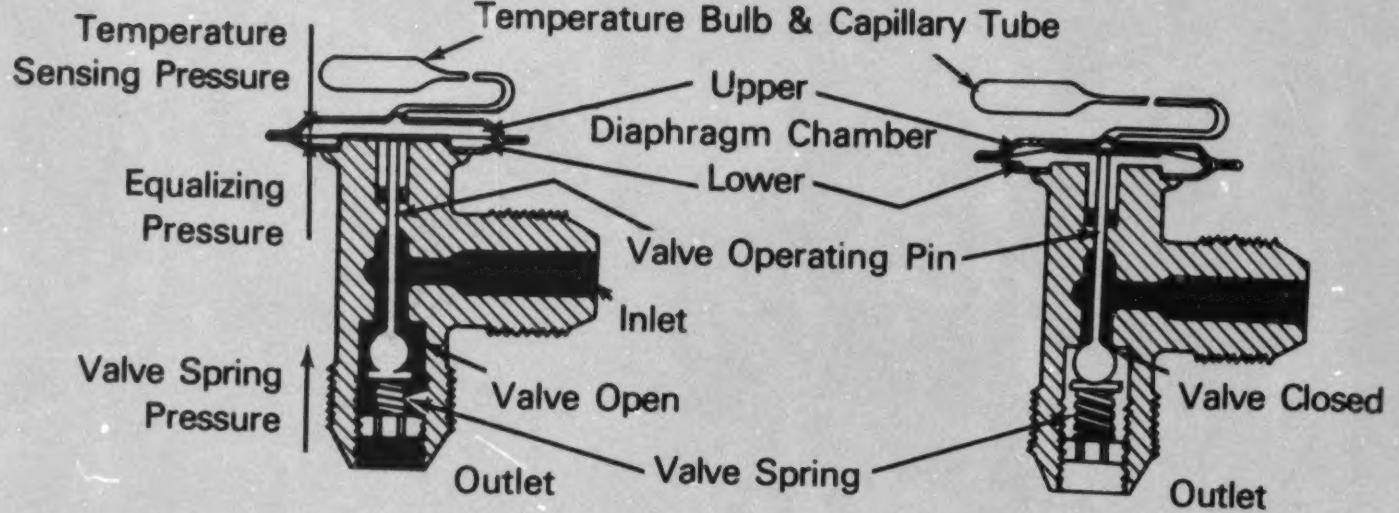

OUTLET
INLET

Foam or heavy stream of bubbles
(Refrigerant very low)


OUTLET
INLET

Oil streaks on glass
(Complete absence of refrigerant)

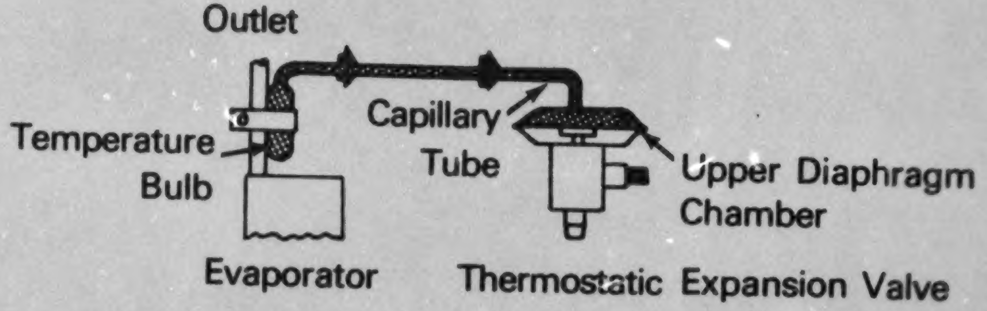
Thermostatic Expansion Valve


Temperature Sensing Pressure
Temperature Bulb & Capillary Tube
Upper
Diaphragm Chamber
Lower
Equalizing Pressure
Valve Operating Pin
Inlet
Valve Spring Pressure
Valve Open
Valve Closed
Outlet
Valve Spring
Outlet

VALVE OPEN

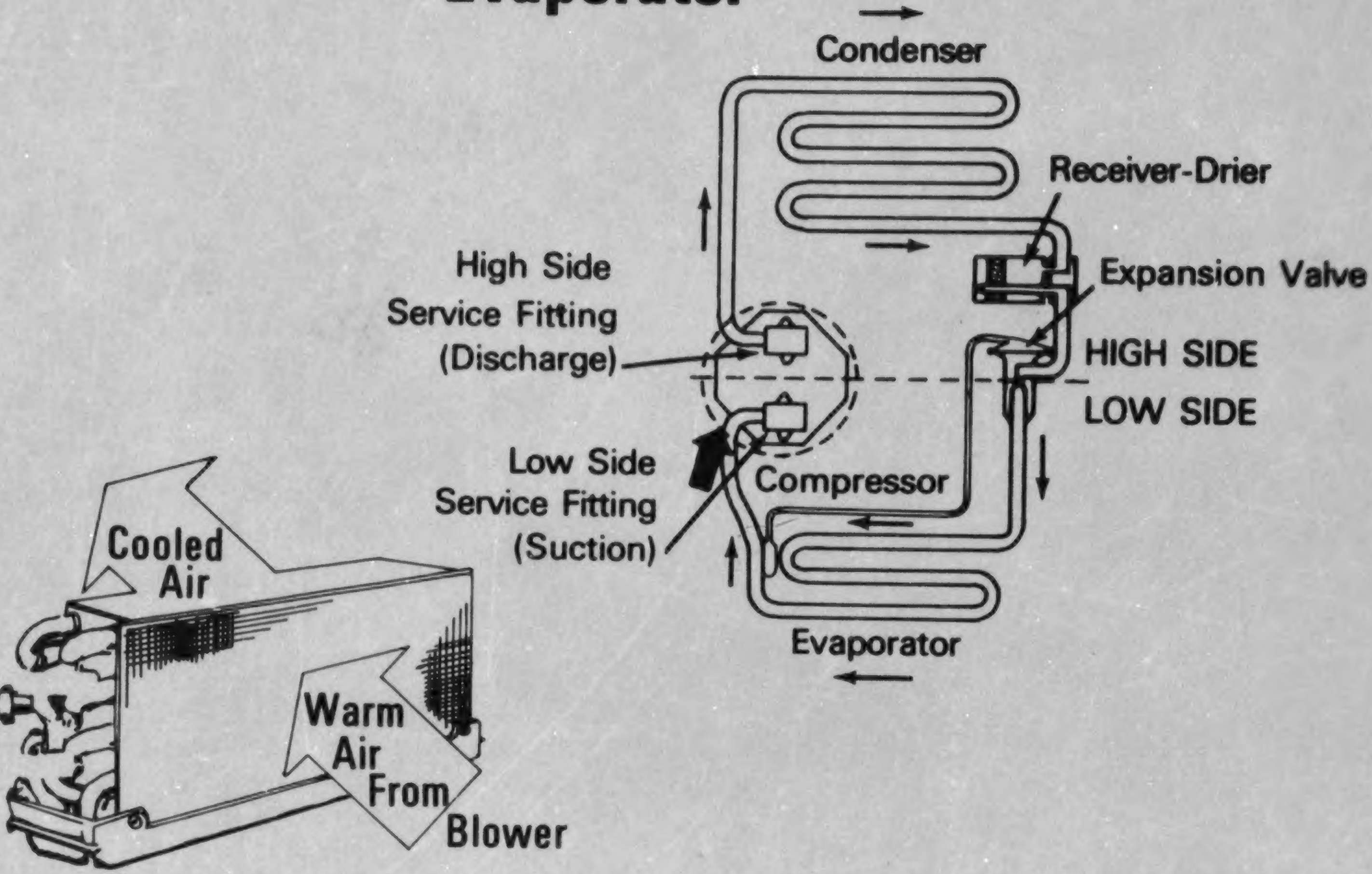
VALVE CLOSED

NOTE: REPLACE VALVE
WITH EXACT REPLACEMENT.


Outlet
Temperature Bulb
Capillary Tube
Upper Diaphragm Chamber
Evaporator
Thermostatic Expansion Valve

TEMPERATURE SENSING BULB

Evaporator


Condenser
Receiver-Drier
Expansion Valve
HIGH SIDE
LOW SIDE
High Side
Service Fitting
(Discharge)
Low Side
Service Fitting
(Suction)
Compressor
Evaporator
Cooled
Air
Warm
Air
From
Blower

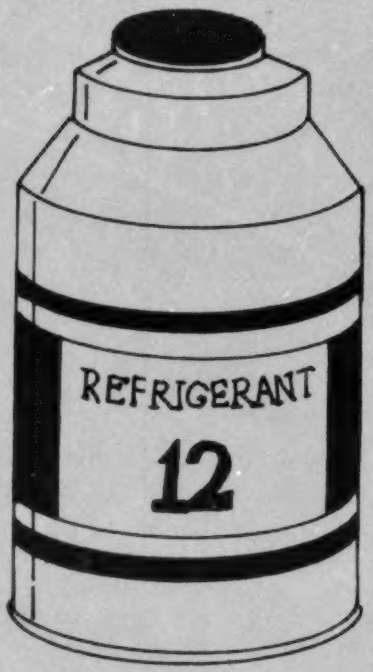
R-12 Must Be a Vapor at Evaporator Outlet

R-12 Refrigerant

Physical Characteristics of Refrigerant-12

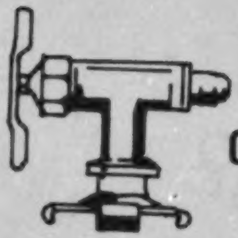
- Nonflammable
- Odorless
- Clear in Color
- Nontoxic
- Noncorrosive to Metal or Rubber Parts
- Ideal Operating Pressures
- High Stability
- Low Boiling Point
- Readily Changes State
- Ability to Absorb Great Quantities of Heat
- High Affinity for Oil

(The most accepted size is the 15 ounce can.)

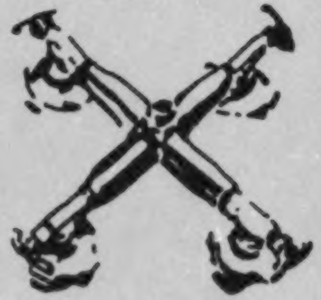


(CAUTION: R-12 only should be used in automotive A.C. systems.)

Refrigerant Can Valve Installation

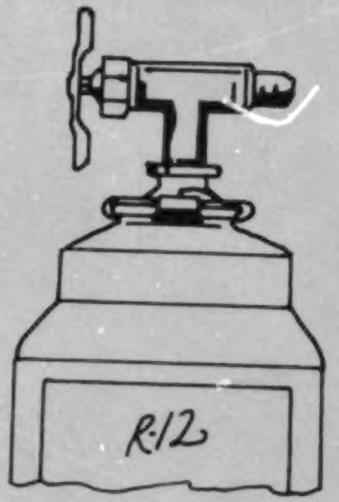


Can Valve



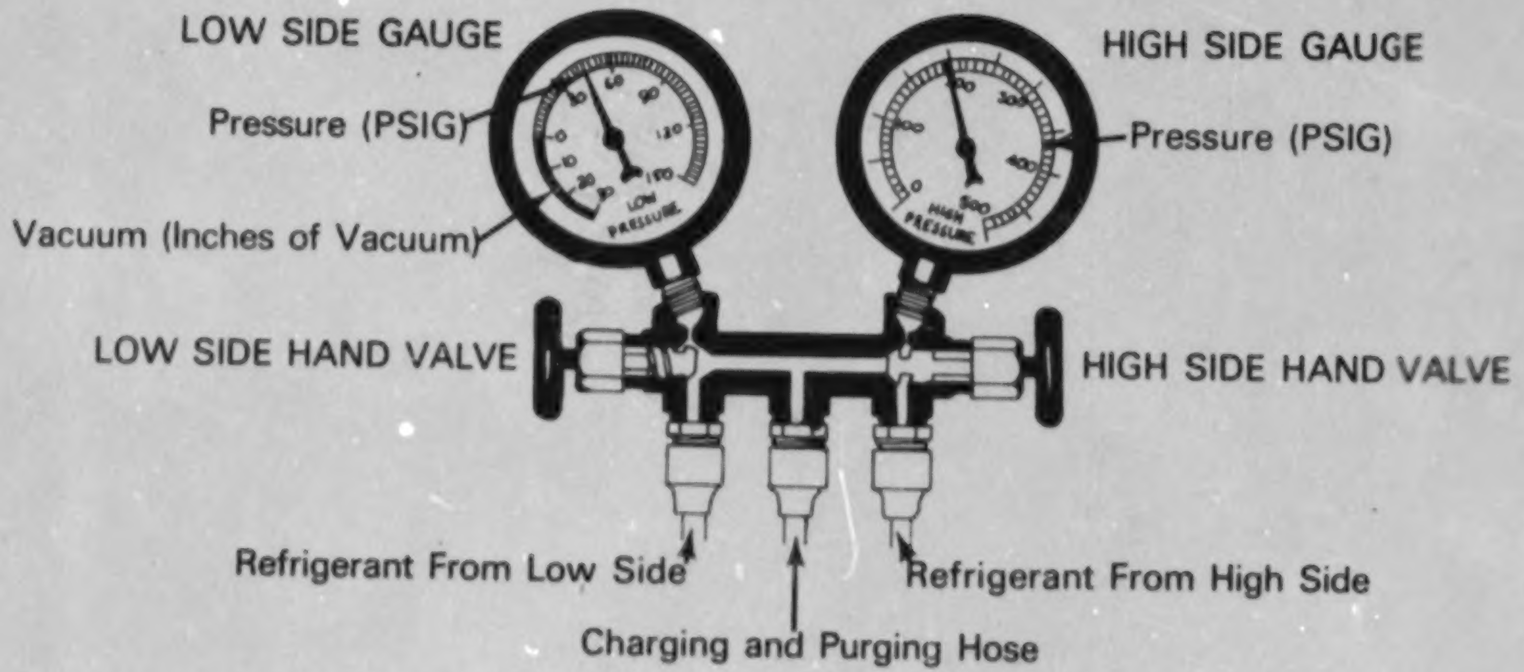
Multiple Dispensing Valve

Can Valve Installed



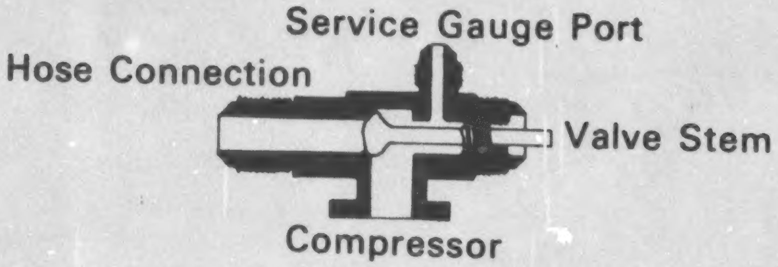
Refrigerant Can

Test Gauge Manifold Set

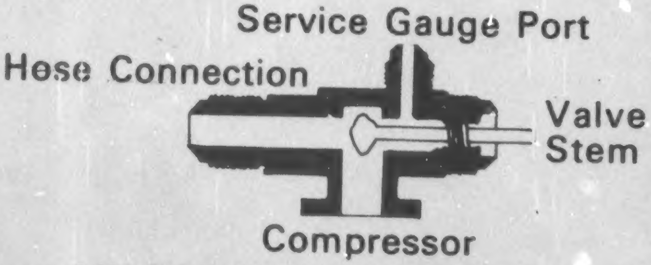

LOW SIDE GAUGE
Pressure (PSIG)
Vacuum (Inches of Vacuum)
LOW SIDE HAND VALVE
30
60
90
120
150
0
10
20
30
LOW PRESSURE
HIGH SIDE GAUGE
Pressure (PSIG)
HIGH SIDE HAND VALVE
0
100
200
300
400
500
HIGH PRESSURE
Refrigerant From Low Side
Charging and Purging Hose
Refrigerant From High Side

LOW PRESSURE SIDE	HIGH SIDE PRESSURE SIDE
Low Side Gauge	High Side Gauge
Manifold	Manifold
Low Side Hand Valve	High Side Hand Valve
Low Side Test Hose	High Side Test Hose

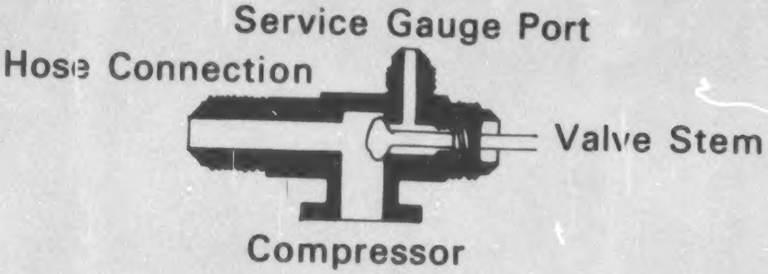
Service Valves


Service Gauge Port
Hose Connection
Valve Stem
Compressor

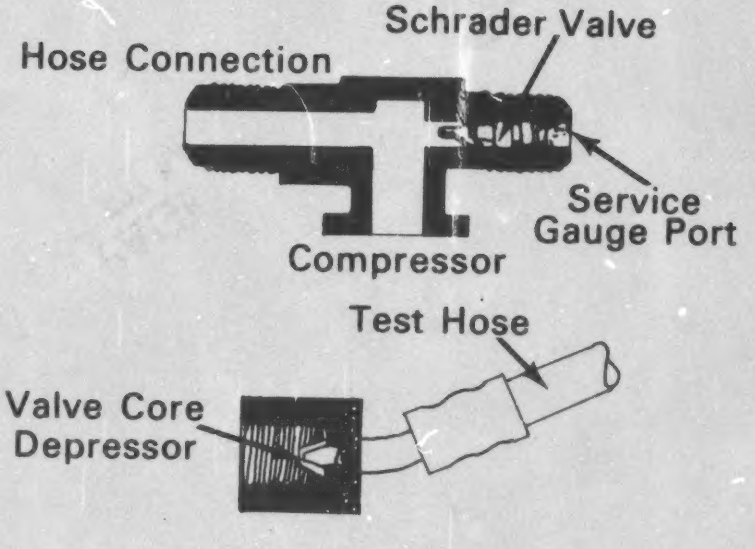
FRONT-SEATED SHUT-OFF POSITION


Service Gauge Port
Hose Connection
Valve Stem
Compressor

MIDPOSITION TEST POSITION


Service Gauge Port
Hose Connection
Valve Stem
Compressor

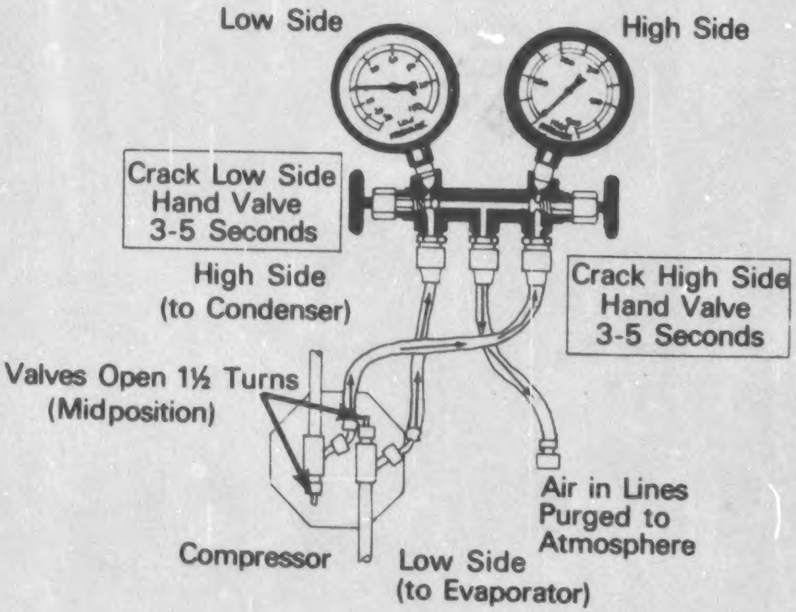
BACK-SEATED OPERATING POSITION


Schrader Valve
Hose Connection
Service Gauge Port
Compressor
Test Hose
Valve Core Depressor

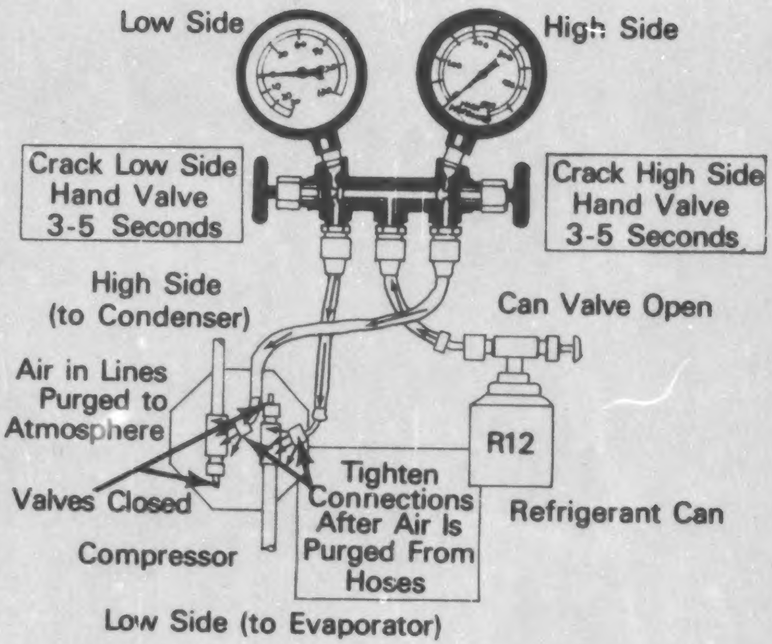
COMPRESSOR FITTING SCHRADER VALVE

Gauge Test Set Connection to System
[Purging]

METHOD 1
(USING SYSTEM REFRIGERANT)


Low Side
High Side
Crack Low Side Hand Valve 3-5 Seconds
High Side (to Condenser)
Crack High Side Hand Valve 3-5 Seconds
Valves Open 1½ Turns (Midposition)
Air in Lines Purged to Atmosphere
Compressor
Low Side (to Evaporator)

METHOD 2
(USING REFRIGERANT CAN)


Low Side
High Side
Crack Low Side Hand Valve 3-5 Seconds
Crack High Side Hand Valve 3-5 Seconds
High Side (to Condenser)
Can Valve Open
Air in Lines Purged to Atmosphere
R12
Valves Closed
Tighten Connections After Air Is Purged From Hoses
Refrigerant Can
Compressor
Low Side (to Evaporator)

NOTE: System must not be operating when purging test hoses.

Pressure-Temperature Relationship

NOTE: Pressures shown are under exact conditions (see Test Conditions) and are not necessarily true for every car checked.
Ambient Temperature is the temperature in the engine compartment (not outside air temperature).

LOW PRESSURE GAUGE READING	EVAPORATOR TEMPERATURE F°
10	2
12	6
14	10
16	14
18	18
20	20
22	22
24	24
26	27
28	29
30	32
35	36
40	42
45	48
50	53
55	58
60	62
65	66
70	70

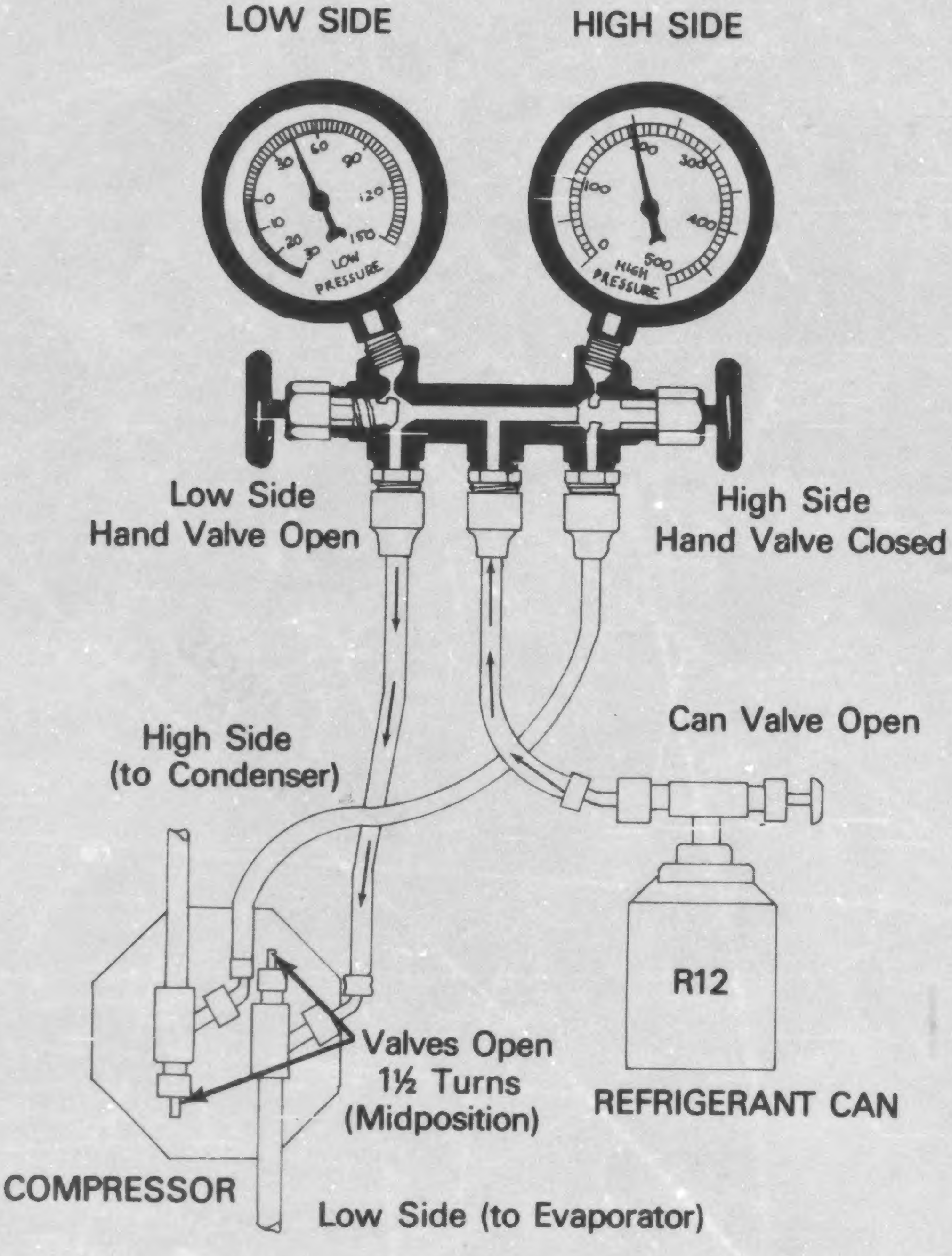
Normal operating ranges shown by dotted line boxes.

AMBIENT TEMPERATURE °F	HIGH PRESSURE GAUGE READING
60	95-115
65	105-125
70	115-135
75	130-150
80	150-170
85	165-185
90	175-195
95	185-205
100	210-230
105	230-250
110	250-270
115	265-285
120	280-310

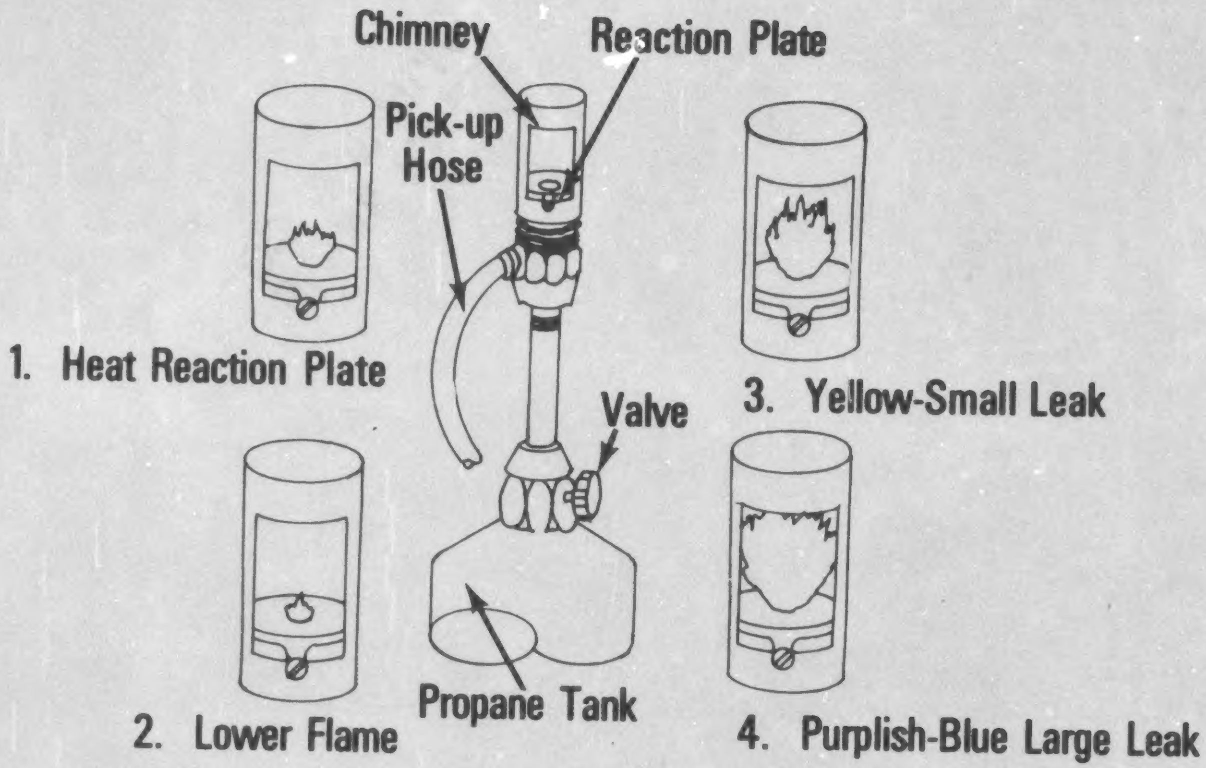
TEST CONDITIONS:

1. Use Large Fan to substitute for normal ram air flow through condenser.
2. Car engine adjusted to normal fast idle speed.
3. System fully charged.
4. All conditions equivalent to 30 MPH.

Adding Refrigerant to System

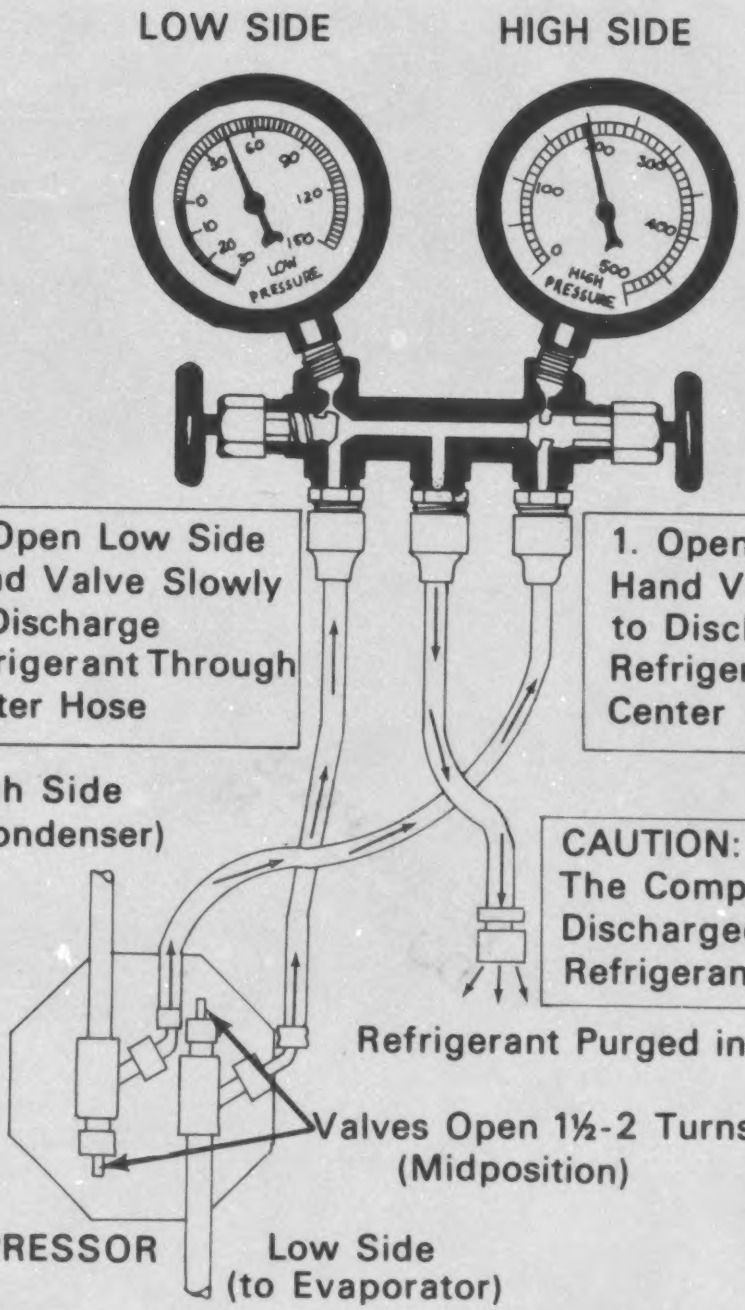

LOW SIDE
HIGH SIDE
30
60
90
0
120
10
20
30
150
LOW PRESSURE
100
200
300
0
400
500
HIGH PRESSURE
Low Side Hand Valve Open
High Side Hand Valve Closed
Can Valve Open
High Side (to Condenser)
R12
Valves Open 1½ Turns (Midposition)
REFRIGERANT CAN
COMPRESSOR
Low Side (to Evaporator)

Halide Leak Detector


Chimney
Reaction Plate
Pick-up Hose
1. Heat Reaction Plate
Valve
3. Yellow-Small Leak
Propane Tank
2. Lower Flame
4. Purplish-Blue Large Leak

PROPANE TORCH LEAK DETECTOR

Discharging the System


LOW SIDE
HIGH SIDE
30
60
90
120
150
0
10
20
30
LOW PRESSURE
0
100
200
300
400
500
HIGH PRESSURE

2. Open Low Side Hand Valve Slowly to Discharge Refrigerant Through Center Hose

1. Open High Side Hand Valve Slowly to Discharge Refrigerant Through Center Hose

High Side (to Condenser)

CAUTION: Do Not Allow The Compressor Oil To Be Discharged With The Refrigerant

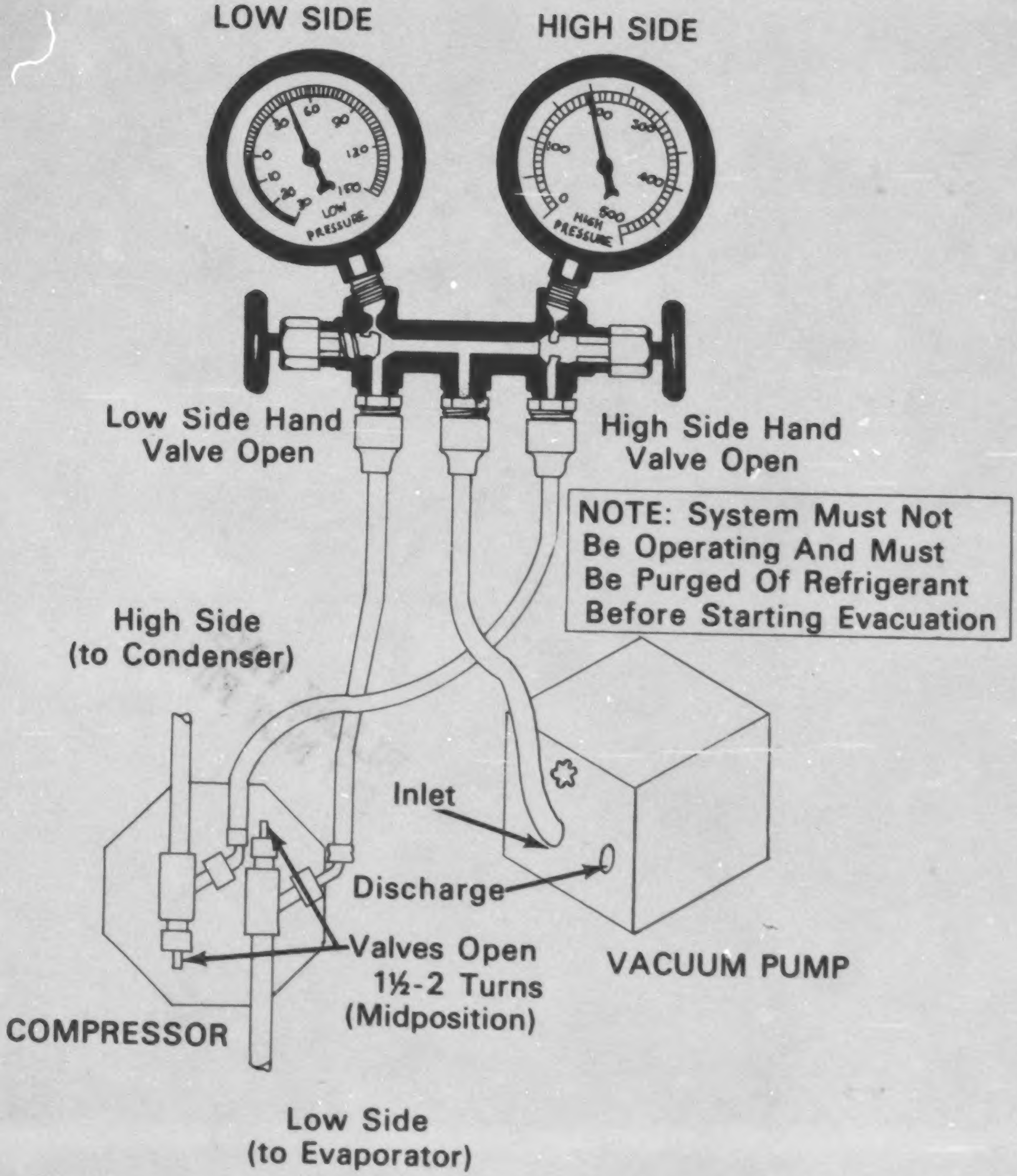
Refrigerant Purged into Can of Rags

Valves Open 1½-2 Turns (Midposition)

COMPRESSOR

Low Side (to Evaporator)

Evacuating the System


LOW SIDE
HIGH SIDE
LOW PRESSURE
HIGH PRESSURE
Low Side Hand Valve Open
High Side Hand Valve Open
High Side (to Condenser)
Inlet
Discharge
Valves Open 1½-2 Turns (Midposition)
VACUUM PUMP
COMPRESSOR
Low Side (to Evaporator)

NOTE: System Must Not Be Operating And Must Be Purged Of Refrigerant Before Starting Evacuation

AIR CONDITIONING
UNIT V

JOB SHEET #1--CONNECT MANIFOLD GAUGE SET INTO SYSTEM

I. Tools and equipment needed

   A. Manifold gauge

   B. Combination wrench set

   C. 6" adjustable wrench

   D. Straight blade screwdriver set

   E. Phillips screwdriver set

II. Procedure

   A. Place fender cover on the car fender

   B. Remove caps from service valve stems

   (CAUTION: Wear safety glasses at all times. Remove caps slowly to insure no refrigerant is leaking past the valves.)

   C. Make sure both service valves are in back seat position

   D. Remove gauge port caps

   E. Connect manifold gauge service hoses to compressor

      1. Low manifold hose to low side (suction)

      2. High manifold hose to high side (discharge) of compressor

      (NOTE: On systems equipped with Schrader type service valves, hoses must be equipped with a depressing pin. If not, use an adapter made for this purpose.)

AIR CONDITIONING
UNIT V

JOB SHEET #2--PURGE THE SYSTEM

I. Tools and equipment needed

   A. Manifold gauge

   B. Combination wrench set

   C. 6" adjustable wrench

   D. Straight blade screwdriver set

   E. Phillips screwdriver set

II. Procedure

   A. Turn manifold gauge valves clockwise to full closed position

   B. Connect low side manifold to suction side of compressor

   (CAUTION: Wear safety glasses.)

   C. Connect high side manifold to the discharge side of the compressor

   (NOTE: All hose connectors are finger tight only.)

   D. Rotate compressor service valve stems two or three turns clockwise

      1. Suction side

      2. Discharge side

   E. Open manifold valves to allow bleed off of refrigerant through center hose

      1. Low side manifold

      2. High side manifold

      (NOTE: The center hose should be placed in a clean rag. If any refrigerant oil is pulled out of the system, it will show up on the rag. Open valves only enough to bleed off refrigerant. Purging rapidly will draw excessive oil from the system. Gauge will read zero when system is purged.)

JOB SHEET #2

F. Close manifold valves when refrigerant ceases to bleed off

G. Remove parts from system as required

  1. Damaged parts

  2. Parts required for replacement of damaged body parts

H. Cap or seal all openings and hoses to avoid the possibility of dirt or foreign matter entering the system

AIR CONDITIONING
UNIT V

JOB SHEET #3--REPAIR OR REPLACE CONDENSER

I. Tools and equipment needed

- A. Combination wrench set
- B. Straight blade screwdriver set
- C. Phillips screwdriver set
- D. Flare nut wrench set

II. Procedure

- A. Remove all body parts as required to get to condenser
- B. Purge the air conditioning system (See Job Sheet #2.)
- C. Remove bolts or screws from condenser bracket
- D. Disconnect gas inlet line and liquid outlet line from condenser
- E. Remove condenser from automobile

  (NOTE: Some condensers are equipped with neoprene "o" rings. Replace before installing condenser. If the condenser is going to be off the automobile for several hours, seal all hose or line openings.)

- F. Repair or replace condenser

  (NOTE: Have a condenser repaired by a professional. Do not attempt it yourself.)

- G. Bolt or screw condenser to automobile

  (NOTE: Remember that the flow of refrigerant is out of the bottom of the condenser toward the thermostatic expansion valve.)

- H. Connect hoses or lines to condenser

  (NOTE: Be sure you have a good seat between condenser and line.)

AIR CONDITIONING
UNIT V

JOB SHEET #4--EVACUATE THE SYSTEM USING A VACUUM PUMP OR CHARGING STATION

I. Tools and equipment needed

A. Manifold gauge

B. Vacuum pump

C. Combination wrench

D. 6" adjustable wrench

E. Straight blade screwdriver set

F. Phillips screwdriver set

II. Procedure

A. Connect manifold gauge to system

B. Place high and low side compressor service valves in the cracked position

C. Close high and low manifold valves

D. Remove protective caps from the inlet and exhaust of the vacuum pump

(NOTE: Make sure the caps are removed to avoid damage to the vacuum pump.)

E. Connect the center manifold hose to the inlet of the vacuum pump

F. Start vacuum pump

G. Open low side of manifold valve and observe gauge needle

(NOTE: It should pull down into a slight vacuum. After five minutes the compound gauge should be below a 20" vacuum and the high side gauge should be slightly below the zero index of the gauge. If the high side needle does not drop below zero, system blockage is indicated. If system is blocked, discontinue evacuation and repair obstruction.)

JOB SHEET #4

H. Close manifold low side valve

(NOTE: Operate vacuum pump for a minimum of fifteen minutes. Low manifold gauge should read 24"-26" vacuum.)

1. Repair leaks

   (NOTE: If system does not go down to 24"-26" vacuum, close low side and observe gauge. If gauge rises, leak is indicated and must be located and repaired.)

2. Pump down system

   (NOTE: If no leak is found or leak is repaired, continue pump down for a minimum of thirty minutes or longer if time permits.)

I. Close low side manifold valve

1. Shut off vacuum pump

2. Check for vacuum readings and leaks

   (NOTE: The compound gauge should read about 29" vacuum and should not rise at a rate faster than 1" in five minutes. If the system fails to meet this requirement, a partial charge must be installed and the system leak tested. If leaks are indicated, the system will have to be repaired, purged, and evacuated. If the system holds the vacuum as specified, continue with the charging procedure.)

AIR CONDITIONING
UNIT V

JOB SHEET #5--LEAK TEST THE SYSTEM USING A HALIDE LEAK DETECTOR

I. Tools and equipment needed

- A. Manifold gauge set
- B. Halide leak detector
- C. Combination wrench
- D. 6" adjustable wrench
- E. Straight blade screwdriver set
- F. Phillips screwdriver set
- G. Refrigerant R-12
- H. Refrigerant can valve

II. Procedure

- A. Connect manifold gauge set into system
- B. Place high and low side manifold valve in the closed position
- C. Place high and low side compressor service valve in the cracked position
- D. Check presence of refrigerant in the system

  (NOTE: A minimum of 50 pounds of pressure is needed for leak detection.)

- E. Add refrigerant if 50 pounds of pressure is not present
  1. Open high and low side manifold valves to purge hoses and then close
  2. Attach center manifold hose to refrigerant container
  3. Open refrigerant container valve
  4. Open low side manifold valve until a pressure of 50 pounds is reached on the high side gauge, then close the low side valve
  5. Close refrigerant container valve

JOB SHEET #5

F. Prepare leak detector (Halide leak detector)--Open valve and light the gas

(NOTE: Adjust flame until it burns about 1/2 inch above reactor plate. Let it burn until the reactor place, a copper element, turns to a cherry red color. Then lower flame until it is about 1/4" above or even with the reactor plate.)

G. Check air conditioning system for leaks

1. Move the search hose under all

    a. Joints

    b. Connections

    c. Seals

    d. Control devices

2. Disconnect any vacuum hoses in the system and check for leaks

    (NOTE: For the reaction of the halide leak detector in presence of refrigerant, see the examples below.)

    Examples:
    a. Pale blue--No refrigerant loss
    b. Pale yellow at edges of flame--Very small refrigerant loss
    c. Yellow--Small amount of refrigerant loss
    d. Purplish blue--Large amount of refrigerant loss
    e. Violet--Heavy amount of refrigerant loss; may be great enough to extinguish flame

    (NOTE: If the system has been purged, the leak detector may sense refrigerant in the atmosphere and indicate a leak when there is none.)

AIR CONDITIONING
UNIT V

JOB SHEET #6--REPAIR LEAKS IN AIR CONDITIONING SYSTEM

I. Tools and equipment needed

- A. Combination wrench
- B. 6" adjustable wrench
- C. Phillips screwdriver set
- D. Straight blade screwdriver set
- E. O ring assortment
- F. Halide leak detector

II. Procedure

- A. Repair leak when located
  1. Joints
  2. Connections
  3. Seals
  4. Control devices

  (NOTE: It may be necessary to purge the system of refrigerant, depending upon the nature and location of the leak. If the system is purged, evacuate system.)

- B. Recheck system for leaks

  (NOTE: If no leaks are found, the system may be charged. If the system has been purged, the leak detector may sense refrigerant in the atmosphere and indicate a leak when there is none.)

AIR CONDITIONING
UNIT V

JOB SHEET #7--CHARGE THE AIR CONDITIONING SYSTEM USING POUND CANS

I. Tools and equipment needed

- A. Manifold gauge set
- B. Vacuum pump
- C. Refrigerant can valve
- D. Combination wrench
- E. Straight blade screwdriver set
- F. Phillips screwdriver set
- G. Refrigerant (R-12)

II. Procedure

- A. Charge the air conditioning system

  (CAUTION: Above 130°, liquid will completely fill a container and pressure will build up rapidly with each degree of temperature added. Never heat a refrigerant container. Never apply a direct flame or an electric resistance heater to a container. Do not abuse a refrigerant container. Use only approved wrenches to open and close valves. Store containers in upright positions. Do not handle refrigerant without suitable eye protection and do not discharge refrigerant into an enclosed area having an open flame.)

- B. Prepare system
  - 1. Connect manifold gauge set into the system with both manifold valves in the front seat position
  - 2. Set compressor high and low side service valves in the cracked position
  - 3. Install can valve to can of refrigerant
    - a. Set can valve in the counterclockwise position
    - b. Attach valve to refrigerant container and secure locking nut if so equipped
    - c. Connect center manifold hose to can valve
    - d. Pierce can by turning shut off valve in the clockwise position

JOB SHEET #7

C. Purge line of air

  1. Turn can valve counterclockwise

     (NOTE: Center hose is now charged with refrigerant and air. Do not crack high or low side manifold valves.)

  2. Loosen center hose connector at manifold set until a hiss can be heard

     (NOTE: Allow gas to escape for a few seconds and then tighten finger tight.)

D. Charge system

  1. Close both manifold valves

  2. Start engine

     a. Adjust engine speed to about 1250 RPM

     b. Speed adjustment held by

        1) Turning idle screw

        2) Setting on high cam

  3. Adjust controls

  4. Open low side manifold valve and allow refrigerant, in the gas state, to enter the system

     (NOTE: After pressure on low side has dropped below 40 pounds, the can may be inverted for more rapid removal of refrigerant.)

     (CAUTION: With the refrigerant can inverted, vapor will rise to the top of the container and liquid refrigerant will be forced into the charging hoses. Do not invert the refrigerant containers with low side pressures in excess of 40 pounds. Regulating the valve on the container or the manifold valve will insure a pressure of 40 pounds or below. Liquid refrigerant entering the compressor low side can cause serious damage to internal parts such as pistons, valves, head, and head gaskets.)

     (NOTE: To determine when can is empty, tap it on the bottom. A hollow ring should be heard when empty.)

     (CAUTION: Never apply heat to refrigerant containers.)

JOB SHEET #7

5. Repeat with additional cans of refrigerant as required to completely charge the system

   (NOTE: Refer to manufacturer's recommendations for system capacity. If system capacity is not known, charge unit until the sight glass is clear, then add one-fourth pound.)

E. Complete system charge

   1. Close low side manifold valve
   2. Close refrigerant can valve
   3. Remove can valve from center hose
   4. Decrease engine RPM to normal
   5. Turn system off
   6. Turn engine off
   7. Back seat compressor service valves
   8. Remove manifold gauge set
   9. Replace all protective caps and covers

AIR CONDITIONING
UNIT V

TEST

1. Match the following terms with the correct definitions. Terms 1 through 10 will be the answers to "a" through "j" definitions.

_____a. A device used to control temperature, humidity, and air movement

_____b. An adjustable door in the plenum blower assembly that permits selection of outside and inside air for heating and cooling systems

_____c. Temperature of air surrounding an air conditioned unit, such as a vehicle or building

_____d. An outside air sensing switch used to control compressor clutch operation and prevent compressor operation at low temperatures when air conditioning is not required

_____e. Refers to turning the service valve stem all the way counterclockwise and "back seating" the valve

_____f. A motor driven fan used to force air through the evaporator and to circulate the cooled air through the passenger compartment of the automobile

_____g. Temperature at which a liquid changes to a vapor

_____h. Mechanical device used to pierce, dispense, and seal small cans of refrigerant

_____i. A specific amount of refrigerant or oil by volume or weight

_____j. The act of placing a charge of refrigerant or oil into the air conditioning system

1. Back seat
2. Can valve
3. Ambient switch
4. Air inlet valve
5. Charging
6. Blower fan
7. Air conditioner
8. Charge
9. Boiling point
10. Ambient air temperature

(NOTE: Terms 11 through 21 will be the answers to definitions "k" through "u.")

_____k. A bimetal device used instead of a fuse to protect a circuit

_____l. A gauge that will register both pressure and vacuum; used on the low side of the system

_____m. Component of the refrigeration system that pumps refrigerant vapor and increases the pressure of the refrigerant

_____n. An assembly mounted on the compressor crankshaft permitting the shaft to be turned without loss of refrigerant or oil

_____o. The act of changing a vapor to a liquid

_____p. Component of a refrigeration system in which refrigerant vapor is changed to a liquid by the removal of heat

_____q. Anything other than refrigerant and refrigeration oil in the system

_____r. A drying agent used in refrigeration systems to remove excess moisture

_____s. To bleed some or all of the refrigerant from a system by opening a valve or connection and permitting the refrigerant to escape slowly

_____t. Connects the compressor outlet to the condenser inlet

_____u. That portion of the refrigeration system under high pressure, extending from the compressor outlet to the thermostatic expansion valve inlet

11. Compound gauge
12. Circuit breaker
13. Compressor
14. Desiccant
15. Discharge side
16. Condenser
17. Contaminants
18. Discharge
19. Discharge line
20. Condensation
21. Compressor shaft seal

(NOTE: Terms 22 through 30 will be the answers to definitions "v" through "dd.")

______v. A device containing desiccant placed in the liquid line to absorb moisture in the system

______w. A v-pulley attached to the crankshaft of an automobile used to drive the compressor clutch pulley by use of a belt

______x. To create a vacuum within a system to remove all trace of air and moisture

______y. Component of an air conditioning system in which refrigerant liquid is changed into a vapor by removing heat from the air which is then discharged into the passenger compartment

______z. A thermometer scale using 32° as the freezing point of water and 212° as the boiling point of water

____aa. A device used with the drier or as a separate unit to remove foreign solid material from the refrigerant

____bb. A condition caused by too much liquid refrigerant being metered into the evaporator

____cc. To remove solid particles such as metal flakes or dirt from refrigerant passages

____dd. The formation of a froth of the oil and refrigerant due to rapid boiling out of the refrigerant dissolved in the oil when the pressure is suddenly reduced

22. Drive pulley
23. Fahrenheit
24. Drier
25. Evacuate
26. Flush
27. Evaporator
28. Filter
29. Flooding
30. Foaming

(NOTE: Terms 31 through 41 will be the answers to definitions "ee" through "oo.")

____ee. Failure of a unit to operate properly due to the formation of ice at the expansion valve orifice or on the evaporator coils or fins

____ff. Closing of the compressor service valves by turning them all the way in, clockwise

____gg. An electrical device used to protect a circuit against accidental overload or unit malfunction

____hh. Pressure of the refrigerant from the discharge reed valve through lines and condenser to the expansion valve orifice

____ii. A term used when the head or high side pressure of the system is excessive

____jj. A device located on the discharge side of the compressor to allow the serviceman to check high side pressures and perform other necessary operations

____kk. Low side pressure higher than normal due to a malfunction of the system

____ll. To isolate or seal off with a nonconductor

____mm. Any device used to detect leaks in an air conditioning system

____nn. Line connecting the drier outlet with the expansion valve inlet

____oo. High side pressure lower than normal due to a malfunction of the system

31. Leak detector
32. Fuse
33. Liquid line
34. Front seat
35. Insulate
36. Head pressure
37. High suction pressure
38. Low head pressure
39. High head pressure
40. Freeze up
41. High side service valve

(NOTE: Terms 42 through 51 will be the answers to definitions "pp" through "yy.")

____pp. A device located on the suction side of the compressor to allow the serviceman to check low side pressures or perform other necessary service operations

____qq. Pressure lower than normal in the suction side of the side of the system due to a malfunction of the unit

____rr. A coupling device used to turn the compressor on and off electrically

____ss. Indicating too much refrigerant or refrigeration oil in the system

____tt. Force per unit of area; the pressure of refrigerant is measured in pounds per square inch (psi)

____uu. The difference in pressure between any two points that may be caused by a restriction or friction

____vv. To remove moisture and air from a system or a component by flushing with a dry gas refrigerant

____ww. Air that is forced through the condenser coils by the movement of the vehicle or action of the fan

____xx. A combination container for the storage of liquid refrigerant and a desiccant

____yy. A positive displacement compressor with pistons that travel back and forth in a cylinder

42. Low side service valve
43. Purge
44. Reciprocating compressor
45. Magnetic clutch
46. Pressure drop
47. Receiver-Drier
48. Overcharge
49. Low suction pressure
50. Ram air
51. Pressure

(NOTE: Terms 52 through 59 will be the answers to definitions "zz" through "ggg.")

____zz. Thin leaves of steel located in the valve plate of automotive compressors to act as suction and discharge valves

____aaa. Refrigerant used in automotive air conditioners

____bbb. The complete circulation of refrigerant through an air conditioning system accompanied by changes in temperature and pressure, such as changes of state from vapor-to-liquid-to-vapor

____ccc. Highly refined oil free from all contaminates, such as sulfur, moisture, and tars

____ddd. A sensing device connected to the expansion valve by a capillary tube to sense temperature and transmit pressure to the expansion valve for its proper operation

____eee. A spring-loaded valve similar to a tire valve located inside the service valve fitting and used on some control devices to hold refrigerant in the system

____fff. A metal mesh located in the receiver, expansion valve, and compressor inlet to prevent particles of dirt from being circulated through the system

____ggg. A fitting on the service valves and some control devices to allow manifold set charging hoses to be connected

52. Refrigeration oil
53. Reed valves
54. Refrigeration cycle
55. Refrigerant-12
56. Screen
57. Service port
58. Remote bulb
59. Schrader valve

(NOTE: Terms 60 through 67 will be the answers to definitions "hhh" through "ooo.")

____hhh. Condition caused by poor air circulation or a thermostat out of adjustment causing the air conditioning unit to run for very short periods

____iii. Information provided by the manufacturer that describes an air conditioning system function

____jjj. Line connecting the evaporator outlet to the compressor inlet

____kkk. That portion of the refrigeration system under low pressure extending from the expansion valve outlet to the compressor inlet

____lll. A back pressure-regulated device that prevents evaporator core freeze up; used by General Motors and consists of a rubber-like piston or bellows

____mmm. Compressor inlet pressure which reflects the pressure of the system on the low side

____nnn. A temperature sensitive switch used to control the compressor clutch and cycle the compressor as a means of temperature control in an air conditioning system

____ooo. A system short of refrigerant which will result in improper cooling

60. Thermostatic switch
61. Suction throttling valve
62. Undercharge
63. Suction side
64. Suction pressure
65. Suction line
66. Short cycling
67. Specifications

(NOTE: Terms 68 through 70 will be the answers to definitions "ppp" through "rrr.")

____ppp. Referring to less than *atmospheric pressure*, expressed in inches of mercury

____qqq. A mechanical device used to evacuate the refrigeration system to rid it of excess moisture and air

____rrr. A gas and specifically the gaseous state of refrigerant

68. Vapor

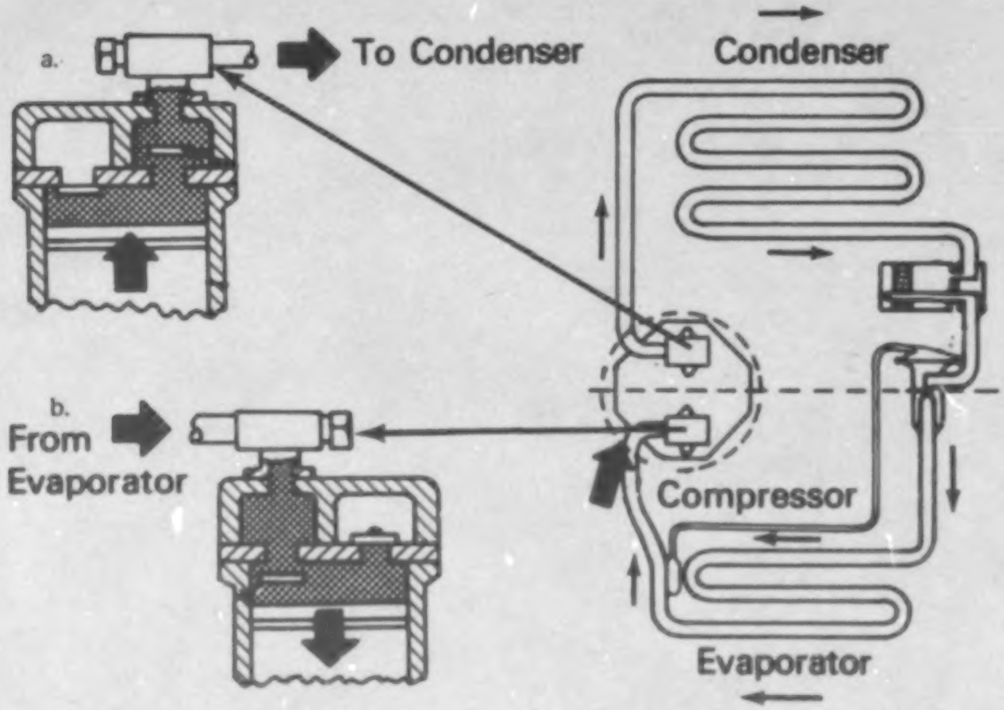
69. Vacuum

70. Vacuum pump

2. Identify the high and low sides of the compressor illustrated below by writing the correct names in the blanks provided.

a. __________ __________

b. __________ __________


a.
To Condenser
Condenser
b.
From Evaporator
Compressor
Evaporator

3. Identify the components of the refrigeration system illustrated below by writing the correct names in the blanks provided.

a. ____________ ____________

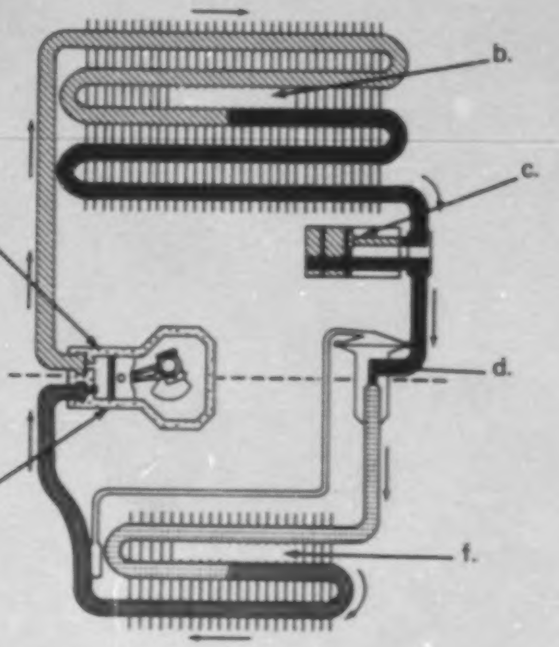
b. ____________ ____________

c. ____________ ____________

d. ____________ ____________

e. ____________ ____________

f. ____________ ____________



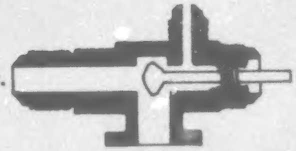
4. Explain the purpose of a receiver-dehydrator (drier).

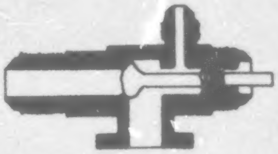
5. Identify the back seat, midpostion, and front seat of a service valve by writing the corrrect names in the blanks provided.

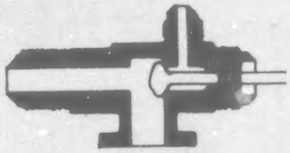
a. __________

b. __________

c. __________

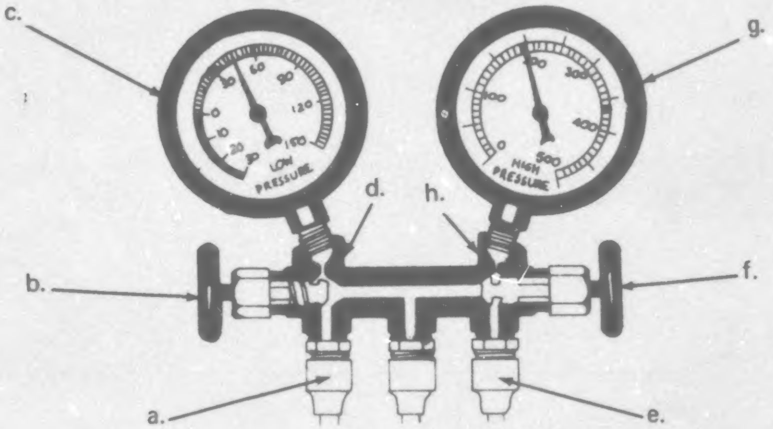
a.


b.


c.


6. Identify the components of the manifold system illustrated below by writing the correct names in the blanks provided.

LOW PRESSURE SIDE	HIGH PRESSURE SIDE
a. __________ __________	e. __________ __________
b. __________ __________	f. __________ __________
c. __________ __________	g. __________ __________
d. __________ __________	h. __________ __________


c.
g.
30
60
90
120
150
0
10
20
30
LOW PRESSURE
200
300
100
400
0
500
HIGH PRESSURE
d.
h.
b.
f.
a.
e.

7. Demonstrate the ability to:
    a. Connect the manifold gauge set into the system.
    b. Purge the system.
    c. Repair or replace a condenser.
    d. Evacuate the system using a vacuum pump or charging station.
    e. Leak test the system using a leak detector.
    f. Repair leaks in the air conditioning system.
    g. Charge the air conditioning system using pound cans.

    (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

AIR CONDITIONING
UNIT V

ANSWERS TO TEST

1.

a.	7	aa.	28	aaa.	55
b.	4	bb.	29	bbb.	54
c.	10	cc.	26	ccc.	52
d.	3	dd.	30	ddd.	58
e.	1	ee.	40	eee.	59
f.	6	ff.	34	fff.	56
g.	9	gg.	32	ggg.	57
h.	2	hh.	36	hhh.	66
i.	8	ii.	39	iii.	67
j.	5	jj.	41	jjj.	65
k.	12	kk.	37	kkk.	63
l.	11	ll.	35	lll.	61
m.	13	mm.	31	mmm.	64
n.	21	nn.	33	nnn.	60
o.	20	oo.	38	ooo.	62
p.	16	pp.	42	ppp.	69
q.	17	qq.	49	qqq.	70
r.	14	rr.	45	rrr.	68
s.	18	ss.	48		
t.	19	tt.	51		
u.	15	uu.	46		
v.	24	vv.	43		
w.	22	ww.	50		
x.	25	xx.	47		
y.	27	yy.	44		
z.	23	zz.	53		

2. a. High side
   b. Low side
3. a. Discharge side of compressor
   b. Condenser
   c. Receiver-Drier
   d. Expansion valve
   e. Suction side of compressor
   f. Evaporator
4. Placed in the system to provide storage of liquid refrigerant and to absorb moisture in the system
5. a. Midposition
   b. Front seat
   c. Back seat
6. a. Low side test hose
   b. Low side hand valve
   c. Low side gauge
   d. Manifold
   e. High side test hose
   f. High side hand valve
   g. High side gauge
   h. Manifold
7. Performance skills will be evaluated according to the criteria listed on the progress chart.

Auto Body
PROGRESS CHART

Section K-1
Miscellaneous

	Unit I Basic Measurement					Unit II Battery Service					Unit III Circuits & Wires									
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	6	7	8	9	
Job	Unit Test	Read a Ruler	Measure Objects	Draw Lines & Objects to Proper Dimensions		Unit Test	Clean & Service a Battery	Remove & Replace a Battery	Check a Battery with a Hydrometer		Unit Test	Install Soldered Terminals	Install Solderless Terminals	Splice a Wire Using Solder	Splice a Wire Without Solder	Remove & Replace a Bulb	Remove & Replace a Sealed Beam	Align Headlight	Remove, Clean, & Replace Power Window Motor	
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
85% Correct																		
Nearest 1/16 of an Inch																		
Nearest 1/16 of an Inch																		
Nearest 1/16 of an Inch																		
85% Correct																		
Corrosion Removed from Terminals, Surface of Battery & Cables																		
Disconnect, Store, and Reinstall According toRecommended Procedur																		
Same Reading in Two of Three Tries for Each Cell																		
85% Correct																		
Use Proper Terminal for Wire & Use Proper Soldering Technique																		
Use Proper Terminal for Wire & Use Proper Wire Stripping Technique																		
Neat & Soldering Technique Correct & Taped Properly																		
Neat, Good Electrical Contact and Taped Properly																		
Use Proper Replacement Part																		
Use Proper Replacement Part According to Equipment Specifications																		
Safely & According to Manufacturer's Specifications																		

Auto Body
PROGRESS CHART

Section K-2
Miscellaneous (continued)

	Unit IV Engine Cooling System							Unit V Air Conditioning System									
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	
Job	Unit Test	Repair & Replace a Water Pump	Repair & Replace a Radiator	Pressure Test the Cooling System	Remove, Inspect, & Replace V-Belts	Test Antifreeze Solution	Unit Test	Connect Manifold Gauge Set into System	Purge the System	Remove & Replace Condenser	Evacuate System	Leak Test the System	Repair Leaks in the Air Conditioning System	Charge the System Using Pound Cans			
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	

Accuracy	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
85% Correct																		
All Bolts Properly Torqued & In Same Hole Sealed & No Leaks																		
All Hoses and Connections Sealed & Mounted Correctly																		
See Manufacturer's Specifications																		
See Manufacturer's Specifications																		
To Meet Conditions in Locality																		
85% Correct																		
Correct Attachment of Manifold to System																		
To Satisfaction of Instructor																		
Proper Connection to all Fillings & Brackets																		
Proper Attachment of Vacuum Pump to System (Should Hold 24"to 26" vacuum for 30 Minutes)																		
To Satisfaction of Instructor																		
Locate Leak and Repair until Leak Detector does not Sense any Refrigerant																		
See Manufacturer's Specifications																		